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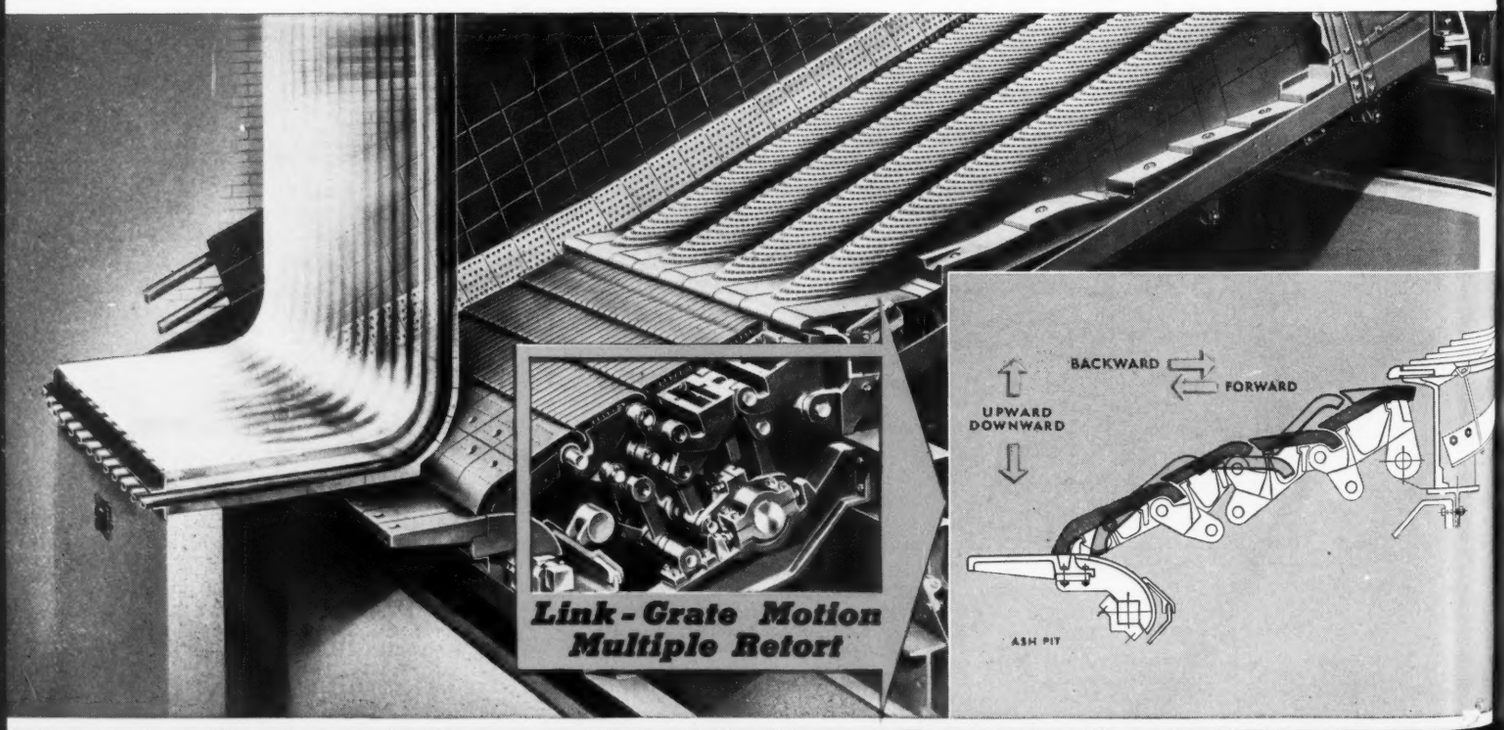

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365 Days of Emergency

Because this is an era of total and mechanized warfare, any major program of national defense is automatically a program of major industrial activity. Thus the present situation clearly spells **industrial emergency** for every one of the 365 days of 1941.

No matter how one views world events, or which of the possible eventualities he considers most likely, there remains the absolute necessity for continued top-speed production of defense equipment and supplies through 1941. That means unparalleled activity of every branch of business and industry that feeds defense, directly or indirectly.

Particularly it means generating more of those kilowatt-hours that are salted away in every industrial product. In 1941 American industry will consume far more kilowatt-hours than ever before. Much of the increase will be supplied by the electric utilities, which are prepared to deliver about 10% more kilowatt-hours than in 1940 and about 10% more peak kilowatts.

The utilities have the advantage of a diversified load. Each industrial plant, on the other hand, must stand or fall by its ability or failure to meet the requirements of the single factory it serves.

Let's picture the individual situation. The defense load creeps up gradually. The plant goes from one shift to two, then three, from five work days to six or seven. For a while the power plant can keep pace, merely working longer hours at the same old load.

If spare power capacity is scanty the first crisis occurs when accustomed nights and weekends are no longer available for essential maintenance work. At that point the power plant is already in trouble if it can't carry the peak load with the largest boiler and the largest generator off the line for repairs.

And that very condition signals worse trouble ahead. When a factory is working all hours and all days to get out the goods, it is clearly headed for an expansion which must be paralleled by an extension in the power plant.

In that race the power plant had better jump the gun, for it *must* finish first, "or else".

Industrial plants that purchase all of their electrical requirements will face this same situation because process and heating steam are as essential as electricity. With the largest boiler down for maintenance, there must always be enough steam generated to keep buildings warm and processes hot.

So far there has been no general jam in equipment supply, but it may come soon if hundreds of industrials suddenly discover the need for new power equipment just when the manufacturers of such equipment find themselves forced to give priority to key defense industries, while they compete unequally with those same industries for certain raw materials, skilled mechanics and engineers.

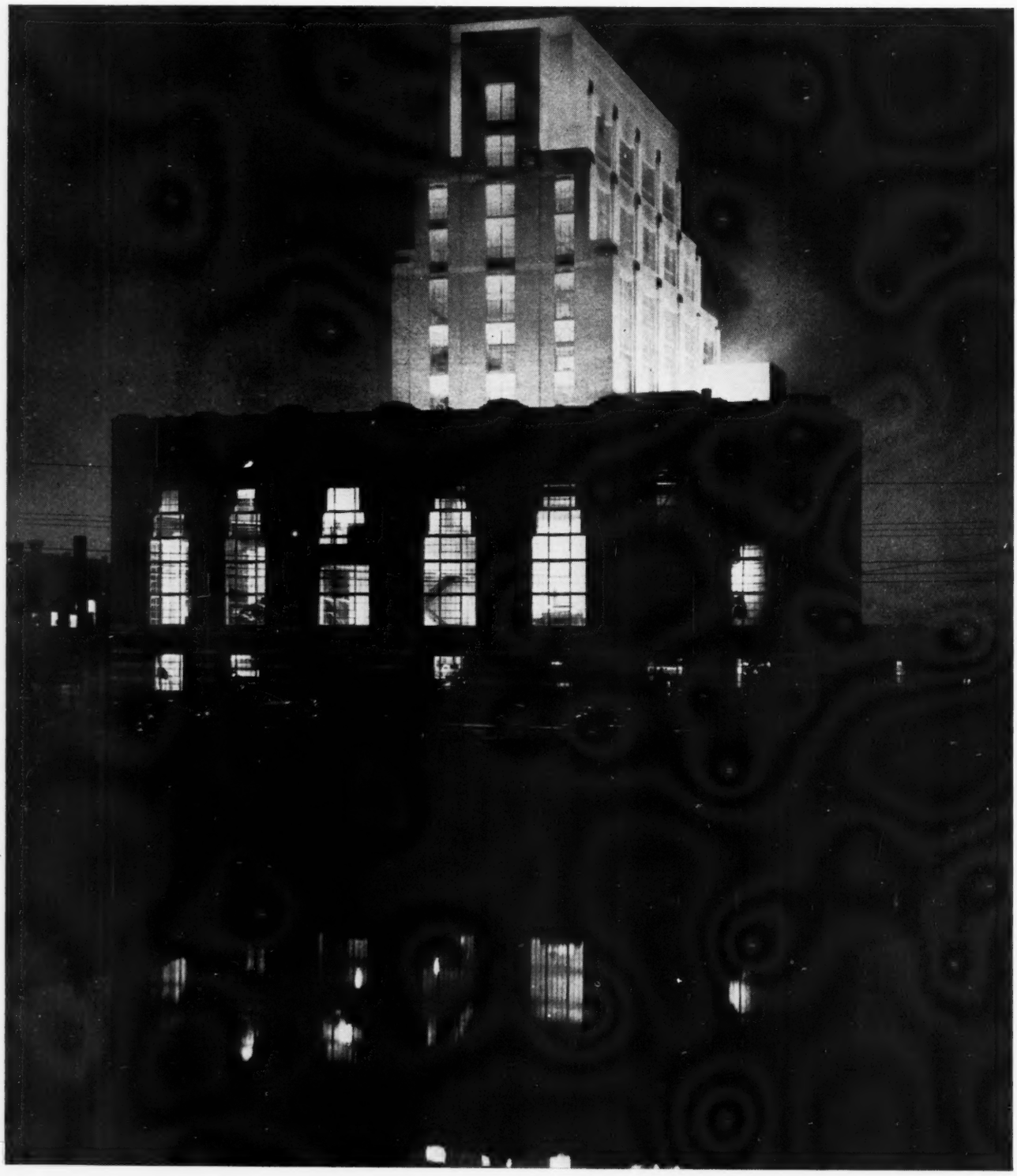
It will be helpful all around if those industrials that will definitely need power equipment reach a decision at once and get their work in the shops while there is still a little slack here and there. This will save dollars in first cost, precious months in delivery, and help American industry to carry the most gigantic load ever laid upon its shoulders.

Now, also, is the time to build additional reserves of effective capacity by eliminating wastes in transmission and application, by re-motoring for better efficiency and higher power factor, insulating against heat leaks, trapping and valving against fluid leaks, repairing or replacing wasteful pumps, fans and compressors, modernizing lubricants and mechanical power transmission, posting meters as policemen to stop waste everywhere.

Such a mechanical housecleaning will save operating dollars both now and in the future. More important, it will help America meet the present emergency by releasing both steam and electrical capacity for essential defense production.

Premeasured Control Pilots High-Efficiency Lansing Station

Fig. 1—Night view of floodlighted stackless "power house" in the midst of downtown Lansing business section



After a year's operation, City of Lansing's Ottawa St Station betters heat rate of most good utility plants. R F Cummings of Burns & Roe, Inc, discusses starting-up problems of district-heating and power-generation cycles

▶ STARTING UP A NEW STATION is a fascinating problem of pitting engineering skill and clear thinking against the minor aches and pains that, unattended, result in shutdowns and repairs. Greater complexity of modern heat cycles, hydrogen cooling of generators, increased application of automatic features of control, all require intimate knowledge of design details as well as long hours of constant vigilance to insure coordinated, safe operation.

In the case of Ottawa St Station, the dual services of district-heating-steam supply and power generation helped rather than hindered the work of getting equipment into preliminary operation. Steam from street mains was brought in to operate one small turbine even before boilers were ready for drying-out fires.

Completed in the latter part of 1939, the plant now operates two 225,000-lb-per-hr, 900-lb, 900-F Babcock & Wilcox steam-generating units serving a 25,000-kw, Allis-Chalmers turbine-generator for electrical supply and two smaller turbine units exhausting to district-heating mains, see POWER, October 1939. The power-generating cycle includes six stages of feedheating, of which four are direct-contact. District steam is supplied by two 130,000-lb-per-hr, Foster Wheeler evaporators, Fig. 3.

Noteworthy Architecture

Noteworthy for its unusual architectural treatment, the station building symbolizes flame by an external coloring from black marble at the base, through deep-red, light-red and sand-color brick to a coping wall that completely conceals two short evasé stacks. Equipment within is of most modern and efficient design so that heat rate per net kwhr equals that of the best comparable public-utility stations.

Even though the full measure of operating economy has not yet been reached, the power-generating cycle already produces electric current at a heat rate approaching 11,000 Btu, about 0.9 lb of coal, per net kwhr sendout. The by-product power generated by the two smaller turbines is, of course, obtained at a much lower heat rate.

Initial operating experiences are of particular interest in that this installation represents the first full-scale application of premeasured combustion control. Similar previous installations at South Amboy (POWER, October, 1934) and Bremo Bluff have metered both coal and air flow to the boilers continuously, but Ottawa St is the first application of the coal-flow measurement to automatic combustion control.

While the combination of district-heating and power-generation cycles complicates normal operation of the plant somewhat in that peaks and valleys in the loads are non-coincident, interconnection of the heating mains actually simplified starting procedure. Steam at 170-lb pressure, supplied to the system by Moores Park Station, was brought into Ottawa St in late October, 1939, to operate a 2500-kw Allis-Chalmers unit exhausting at about 10-lb pressure back to the heating mains or for station use. Thus, both steam and power were available before the first fires were lighted in the new boilers.

Return condensate, mostly trapped from street mains but supplemented by condensing some of the low-pressure exhaust, was available for boiling out the new steam-generating units. Standard recommendations of the manufacturer were followed for bringing pressure up in easy stages. Relatively high concentrations of Calgonite in the boiler water aided in dissolving deposits which were gradually removed by blowing down between pressure-raising intervals. Lighting-off torches supplied drying and boiling-out fires.

In November, 1939, steam from the first boiler was passed through the reducing valve and Elliott desuperheater from 900-lb boiler pressure to the 225-lb evaporator pressure, coincident with tuning up the evaporator circuits, pumps, feed-treatment plant and associated equipment. Cutting in the 4000-kw unit to take over from the reducing valve between 900- to 225-lb pressures then became a simple matter.

Greatest coal savings were offered by getting the heating system in operation in December prior to running the large main unit. Transfer of steam load from Moores Park to Ottawa St resulted in more immediate benefit than if the generating load were picked up. A substantial portion of the downtown Lansing heating load has been carried by Ottawa St during last winter and at present, except when adjustments were

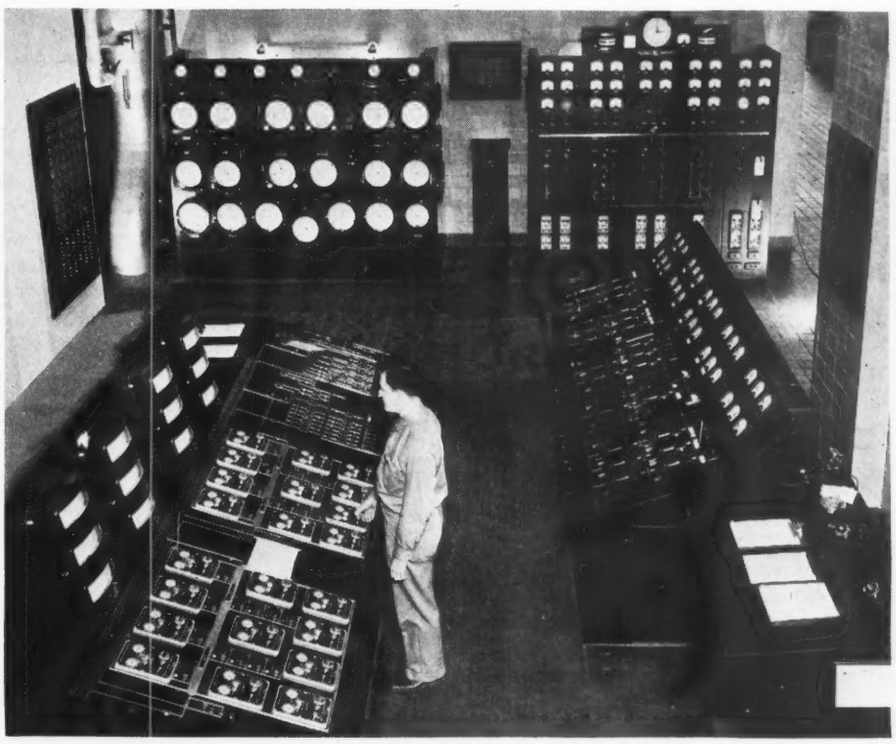


Fig. 2—Centralization of control panels in a single quiet enclosure gives one operator complete supervision of boiler conditions, heat balance, steam and electric output

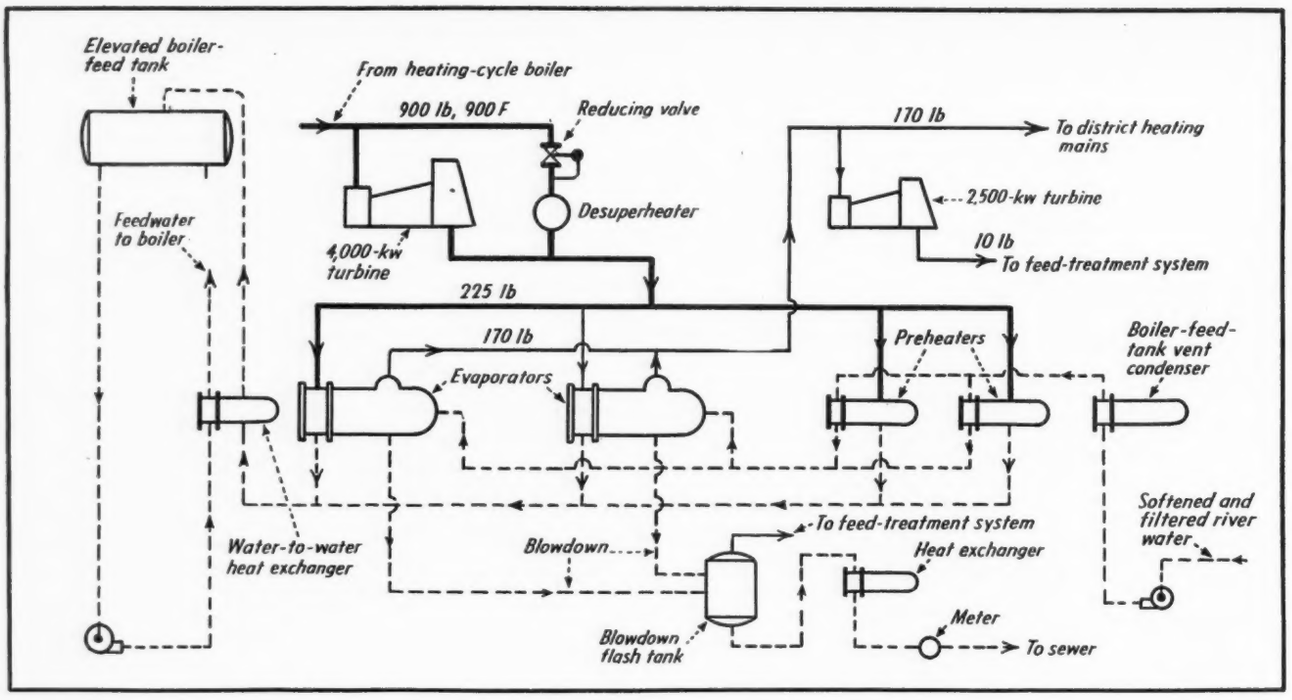


Fig. 3—Pretreatment of Grand River makeup and adequate continuous blowdown has kept heating-system evaporators free of scale

made at Ottawa St. Peak demand is about 175,000 lb per hr.

Evaporator operation has been carried out as originally planned, that is, both units are normally kept on the line even at times of low load. A continuous blowdown system keeps evaporator solids below 3000 ppm, a figure determined by experience as safe for preventing formation of hard scale on evaporator tubes. Quantity of blowdown is calculated beforehand from expected steam load and regulated by hand valve for constant flow over a 24-hr period.

Makeup for the high-pressure boilers has so far been taken only from heating system condensate treated in accordance with recommendations of Hall Laboratories. Inspection has shown no signs of economizer corrosion or other untoward conditions on inner boiler surfaces.

Raw-Water Supply

Pretreated water supplied the evaporators is taken from the Grand River. Raw-water conditions vary widely, especially after a rainfall which washes oily materials into the river from city streets and drains. Ammonia also enters the station from this source and early checks showed as high as one ppm in parts of the condensate piping system. Discovery of this condition can be credited to foresight in arranging for Hall Laboratories staff to maintain complete chemical checkup during starting with the aid of usual operating personnel. The latter, familiarized with the procedures and starting with confidence in known conditions, have since maintained such checks as routine. Ammonia concentrations now rarely reach 0.4 ppm, a reasonable value.

The main 25,000-kw hydrogen-cooled generating unit began operation in February, 1940, although the second boiler had been commissioned nearly two months earlier. Since that time, one boiler has normally supplied the heating system and one the power-generating cycle. Occasional outages for minor repairs and low-load periods have been provided for by piping interconnections and these have been utilized from time to time.

Generator Cooling

Hydrogen cooling of the generator has presented no unusual problems. Quantity of makeup approximates 40 cu ft per day. Original design called for 2-oz hydrogen pressure at full load of 25,000 kw at 0.8 pf, but overload up to 31,250 kw at 0.8 pf was guaranteed with hydrogen pressure increased to about 9 lb. Checks show the hydrogen system will cool the windings satisfactorily at this overload if the pressure is raised to only about 0.5 lb.

Equipment tests and general operating observations indicate that the performance will be close to design figures when load conditions and operating routines have become stabilized long enough to enable accumulation of representative monthly data. Full-load turbine heat rate is slightly below 9000 Btu per kwhr at the generator terminals and boiler efficiency tests about 86%. It will be difficult to segregate monthly performance of the generating cycle from the heating cycle except in the summer months.

First Operation

Early operation of the steam-generating units was undertaken with hand regulation of coal and air flows with the assistance of remote manual equipment provided for the purpose. This not only gave opportunity to tune up each regulator separately but familiarized the operating staff with the controls, a precaution against future contingencies that might require hand operation in emergency.

All automatic features of the combustion-control system have now been in operation for a sufficient time to establish confidence in their reliable performance. Coal for each pulverizer is weighed by a conveyor scale, Fig. 4, between the feeder and the pulverizer inlet. Primary and secondary air flows are measured by orifices. Readings of fuel flow are relayed to the control room by Selsyn motors.

Forced-Draft-Fan Control

Forced-draft-fan speed is controlled by a hydraulic coupling to maintain constant primary-air-duct pressure. Induced-draft-fan speed, also controlled by hydraulic coupling, is regulated to hold constant furnace draft. Separate dampers control the primary air supply

to each pulverizer and the secondary air to each burner.

Air-loaded regulators, functioning through averaging relays, maintain a fixed ratio between coal and total air for combustion over the full range of steam output. Since coal flow, primary and secondary air flows to each burner are indicated continuously on a 3-element indicating meter in the control room, the operator has a running check on combustion conditions.

Coal Flow

When an increase in load occurs, fuel and air quantities are increased by the slight fall in steam pressure acting on the master controller to increase the loading air pressure. Principal new feature of the control system is the utilization of the coal weight flow, as indicated almost instantly by the conveyor scale, as part of the control mechanism to regulate the fuel-air mixture. Previous installations have used the conveyor scale to give indication of change in rate of coal feed to the pulverizer, but have required hand adjustment of the fuel-air ratio.

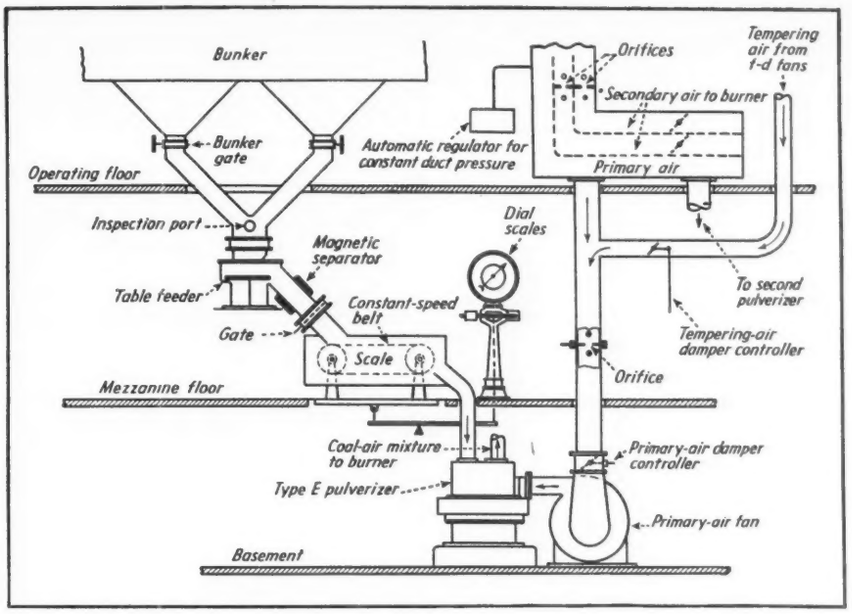


Fig. 4—Conveyor scale between coal feeder and pulverizer, the heart of the pre-measured combustion-control system, gives continuous indication of fuel-burning rate

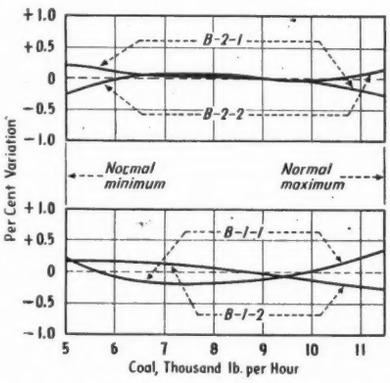


Fig. 5—Conveyor-scale calibration indicates metering accuracy within one-third percent over full range of firing rates

Careful calibration of the coal conveyor scale shows by weight tests that, between 5000 and 11,500 lb per hr, a maximum variation from true weight is less than one-third percent.

Colorful by day because of the shaded brick exterior walls, the station is brightly illuminated by General Electric floodlighting during the dark hours.

Ottawa St has now taken its place as an integral part of the electric and steam-supply system of the City of Lansing. The Board of Water and Electric Light Commissioners have accomplished a threefold objective—a plant of high thermal efficiency at reasonably low cost, a reliable source of steam as well as power in a central location, and architectural construction that adds to rather than detracts from the appearance of the neighborhood without either smoke or dust nuisance.

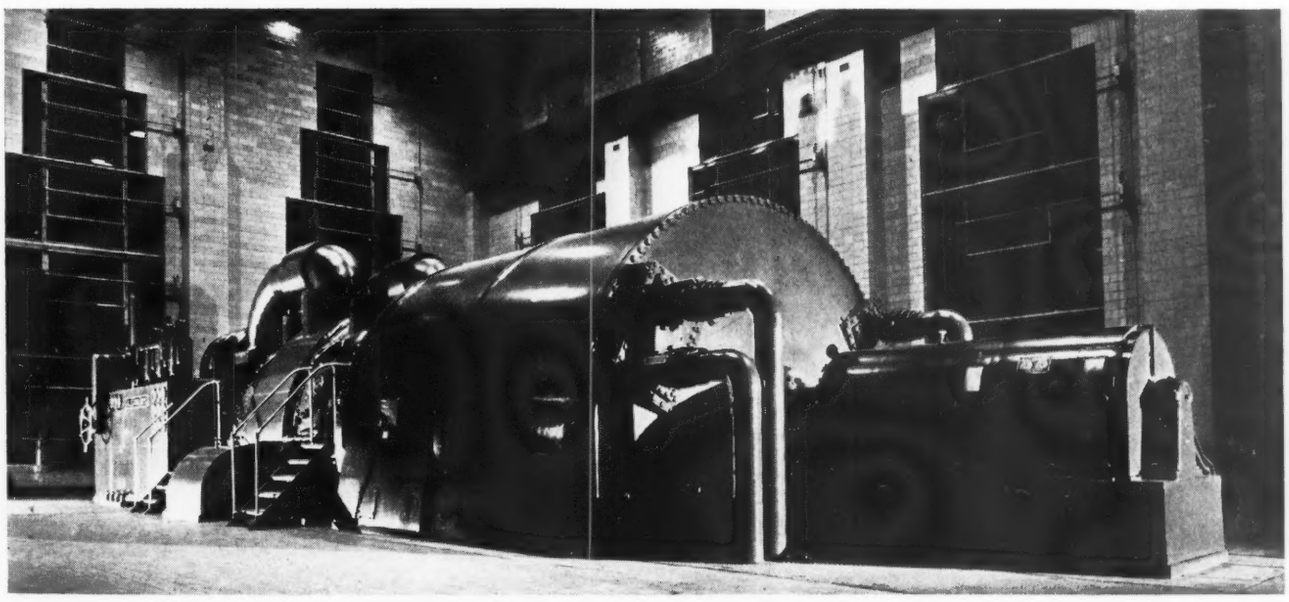
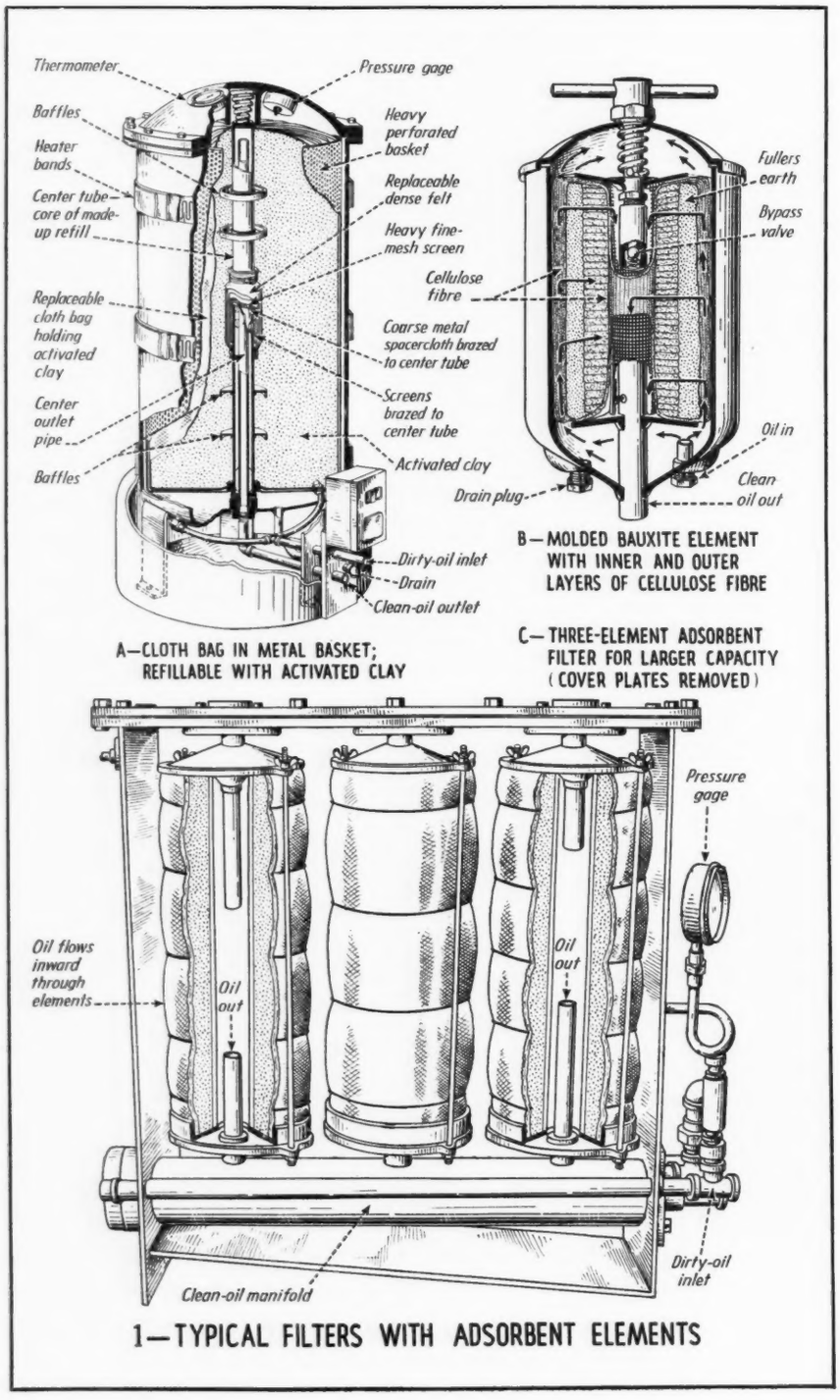


Fig. 6—Main power-generating unit—Allis-Chalmers, 25,000-kw, 825-lb, 900-F, 3600-rpm turbine with hydrogen-cooled generator. Original design called for 2-oz hydrogen pressure at full load of 25,000 kw at 0.8 pf; experience showed that the hydrogen system will cool the windings satisfactorily at overloads up to 31,250 kw at 0.8 pf if pressure is raised to only about 0.5 lb

Clean Diesel Oil Lasts Longer

In this second article, S S Hansen, Chief Lubrication Engineer, General Petroleum Corp, completes his roundup of lube-oil purification methods, presenting practical data on adsorbent filters and chemical treatment



1—TYPICAL FILTERS WITH ADSORBENT ELEMENTS

[*In January* POWER, *pages 70-73, S. S. Hansen discussed the reasons for purifying lubricating oils for diesel engines and presented practical information on mechanical purification methods, including batch settling tanks, centrifuges, gravity filters, adsorbent filters, and edge filters—Ed.*]

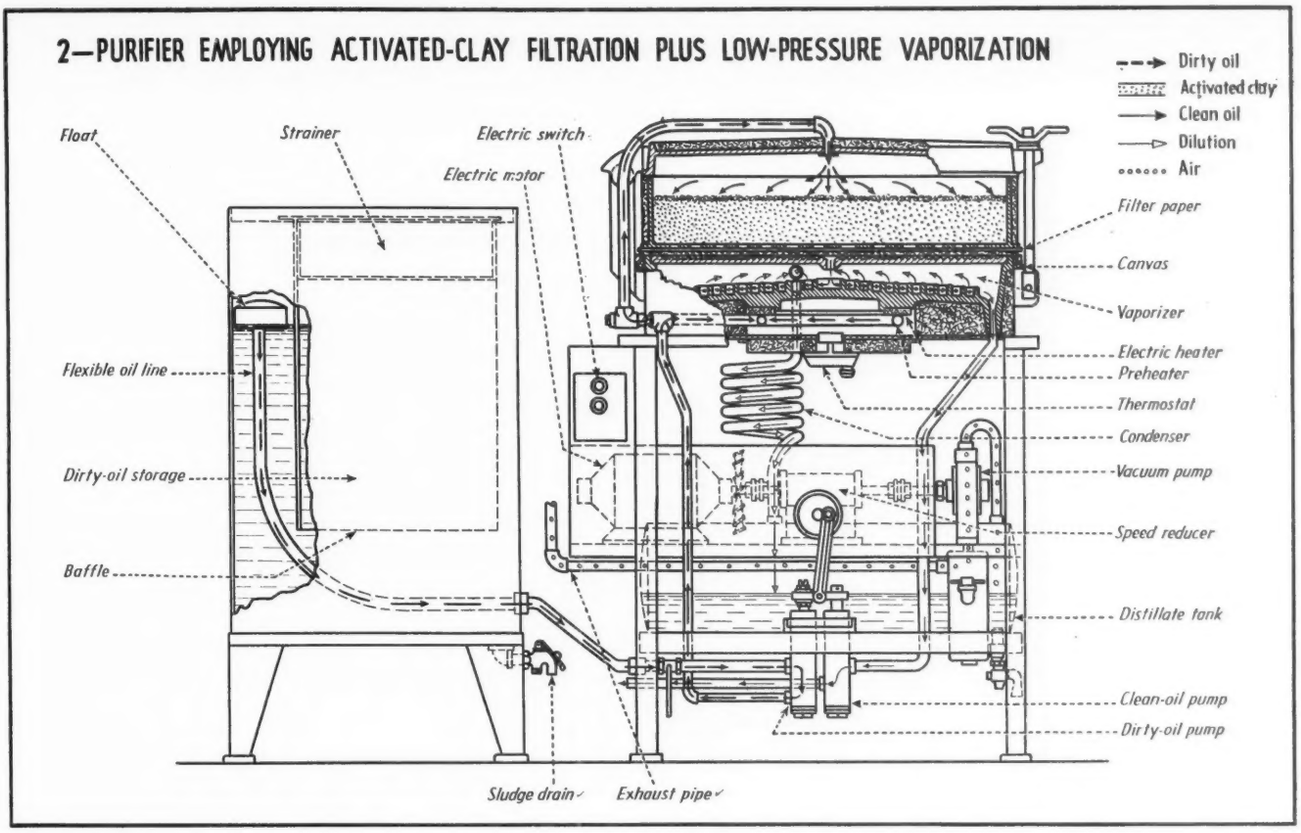
▶ THE SECOND GENERAL CLASS of purifiers includes those using activated clay. These range from the simple cartridge type to more complex units with provision for heating, agitating with clay, and filtering.

Fig. 1 shows several types of adsorbent purifiers using activated-clay cartridges or elements. Material used as adsorbent may be Fuller's earth, bauxite, Bentonite, charcoal, or combinations of these materials, depending on the equipment involved. In the unit shown at 1*B*, the cartridge combines layers of cellulose and molded bauxite. Oil passes first through the outer cellulose layer which removes visible particles, then through the porous bauxite block which adsorbs acids and oxidation products, and finally through an inner layer of cellulose for further cleaning.

Activated-Clay Filter

In the unit, Fig. 1*A*, the activated clay is held in a filter-cloth bag, resting in a perforated metal basket. Dirty oil, under pressure, enters the unit through the inlet at the bottom and divides to enter the element at two points. After passing through the basket and filter-cloth bag, the oil percolates through the activated clay toward the center outlet. To reach the outlet the purified oil must pass through three layers of wool felt and a fine-mesh screen, rise to the top of the center pipe and then pass down the center pipe to the bottom. Units of this type can be fitted with electric heaters. When the clay loses its effectiveness after continued use, the filter-cloth bag is dumped and refilled with fresh adsorbent.

The 3-cartridge unit shown in 1*C* represents an arrangement of the molded-element type for larger capacities; more cartridges may be used as required. Dirty oil from the engine enters the housing through the small pipe at the bottom and in front of the filter. It flows inward through the elements and discharges to a manifold at



the bottom rear from which it returns to the engine. The pressure-relief valve at the right connects directly from the inlet to the outlet and assures operation at correct pressure drop.

Units of the general type illustrated in Fig. 1 usually operate on a continuous-bypass hookup but may be used for batch purifying if so desired. Where engine pump pressure cannot be used to handle the oil through the purifier, an auxiliary pump is required; this may be built-in on some units.

Capacity of Adsorbent Types

Filters of the adsorbent type remove colloidal carbon, asphaltenes, and sludge. Inability to provide large amounts of adsorbent material in a small filter makes reduction of neutralization number difficult. For example, a small engine with a crankcase capacity of 5 gal and a flow rate of approximately one gal per min. using a filter containing 10 lb of adsorbent clay, will have a treating rate of approximately 600 gal of oil per lb of clay for 100 hr operation. At this rate, it is obviously impossible to have any great effect on the acid or acid-forming constituents.

Fig. 2 shows the operation of a somewhat more complicated unit, designed to perform several functions. As shown, with a dirty-oil storage tank, the unit is arranged for batch reclaiming, but can be hooked up for either continuous or intermittent bypass reclaiming or any combination of these three basic systems. As shown, dirty oil enters the storage tank through a strainer which removes large foreign particles. A float-suspended flexible oil line draws oil from the top, supplying a plunger pump. At each pump stroke, a measured quantity of oil flows through the electric preheater which heats it to a predetermined temperature, under thermostatic control. Heated oil flows steadily to the filter assembly, consisting of a bed of activated clay, filter paper, and canvas.

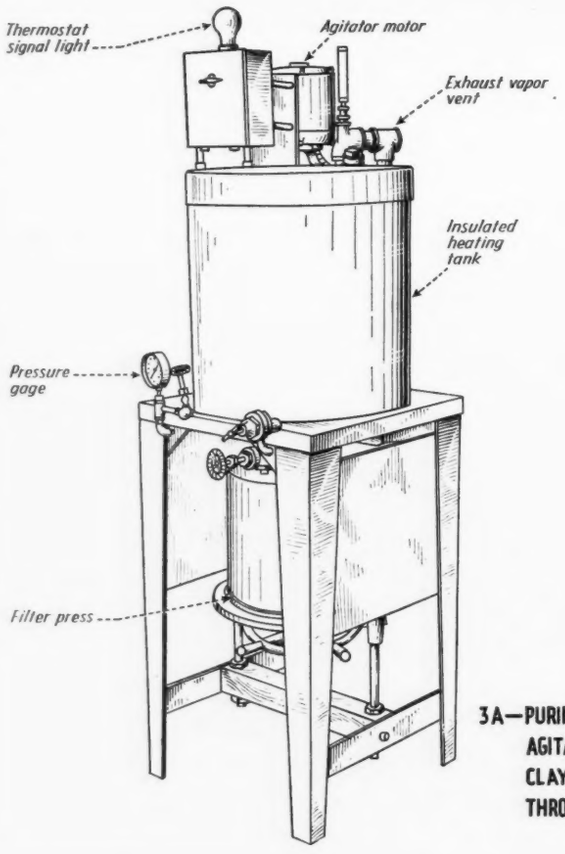
A vacuum pump draws oil through these filtering materials in the order named; clean oil drops to the center of the electrically heated vaporizer. Oil flows in a thin film through the concentric grooves of the vaporizer and the heat and vacuum combine to remove moisture and fuel dilution at a temperature low enough to avoid cracking of the oil.

The purifier shown in Fig. 3*A* employs intimate contact between oil and activated clay. In the tank, filtering earth is dumped into the dirty oil and the mixture heated under thermostatic control to remove water and fuel dilution. A motor-driven agitator keeps the oil in violent motion and so accelerates the action. A blower wheel draws a current of air through the upper part of the tank to carry water and fuel vapors to the exhaust vent. Heated oil drops by gravity to a vertical filter press below. Air pressure from the plant compressor, acting in the filter-press dome, pushes the oil out, leaving a filter cake composed of activated clay and oil impurities. With small engines, the simplest procedure is to drain periodically and reclaim all the oil; for larger units, a part of the oil is withdrawn at intervals for reclaiming.

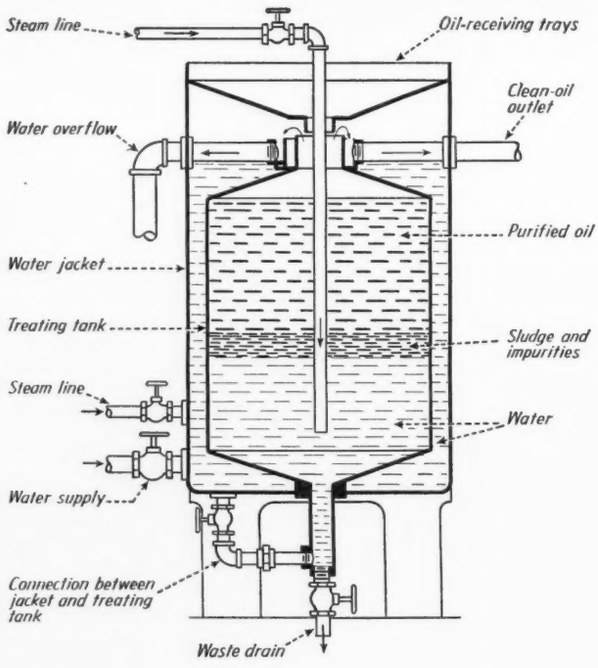
Reclaimers of these types are effective in removing contaminants, even reducing fuel dilution. It is not practical to eliminate all fuel dilution, as the boiling range of the fuel overlaps that of the oil. From the standpoint of appearance and purity, oil clarified by one of these devices is excellent. It is bright and sometimes even lighter in color than the original product.

May Remove Additives

By far the most important point to consider in connection with use of adsorbent filters is that they have a tendency to remove addition agents and inhibitors from some types of compounded lubricating oils. These additives have demonstrated beyond all doubt their ability to retard oxidation and subsequent sticky sludge formation, to retard formation of sticky carbonaceous materials in and around piston rings and combustion chambers, to increase the oil's lubrication charac-



3A—PURIFIER IN WHICH OIL IS AGITATED WITH ACTIVATED CLAY AND THEN PASSED THROUGH A FILTER PRESS



3B—JACKETED TANK FOR TREATING OIL WITH HEAT, WATER AND CHEMICALS SUCH AS SULPHURIC ACID, SODA ASH, OR SODIUM SILICATE

teristics, and to maintain a low organic acid buildup. While not yet widely used on large engines, compounded oils have proved the answer to the lubrication problems of the small high-speed diesel.

In many cases, these valuable qualities attained by the use of inhibitors or addition agents are constantly safeguarded by addition of new makeup oil. In other cases, the addition agent may be of such a nature that it is not affected by adsorbent filtering. Some filter elements are saturated with addition agents when new, to overcome the removal problem, but this plan requires matching the treated filter element to the composition of the oil. In general, where the advantages of adsorbent filtering are wanted but where compounded oil is used, secure the advice of the engine builder, the oil supplier and the filter manufacturer.

Chemical Filters

Still a third type of purifier employs a chemical agent, which may be either sulphuric acid, soda ash, or sodium silicate, depending on the oil to be treated. Fig. 3*B* shows a 2-compartment tank designed for this kind of treating. Water is admitted to the inner compartment until the open end of the steam line is submerged. The steam line is then cracked and steam admitted until water temperature rises to approximately 180 F. At the same time, steam is admitted to the jacket, heating the jacket water. After required temperature is reached, dirty oil is introduced slowly, preferably below water level, where it becomes intimately mixed with the water.

A solution made by dissolving soda ash in hot water is now added to the inner tank (one lb soda ash to 10 gal oil). When sufficient oil has been added to bring the level of the mixture almost to the top, flow is shut off but heating and agitation are allowed to continue for about 15 min., after which steam is shut off and the treated oil allowed to stand over night.

Where sulphuric acid is used, the method closely approximates re-refining of the oil; a complete setup would include treatment with acid, neutralization, and filtering through activated clay or the equivalent. Properly handled, this procedure is highly effective, but the need for expert supervision and the consequent difficulty of maintaining the standard of the reclaimed oil's quality keep it from general use.

In summarizing this matter of purifying diesel oil, it is well to keep in mind that purification is of value principally because it increases the life of the oil. This, in itself, is adequate reason for investment in purification equipment. Actual field experience does not indicate that engine performance is measurably improved, or that there is less tendency toward ring sticking or combustion-chamber deposits. Furthermore, bearing life, liner life, etc, are not materially affected by purification.

Regular Drain Periods

The operator must remember that regular drain periods, as recommended by the engine builder and oil refiner, must be adhered to. Laboratory analysis of used oil is the most accurate guide to correct draining procedure; do not go by appearance. Likewise, operators must bear in mind that some filters remove some addition agents and specialized advice should be secured about filtration of compounded oils.

Many authorities feel that installation and maintenance of proper air filters, crankcase air filters, and proper mechanical operation of the engine are of equal importance with treatment of oil. In other words, prevention of contamination and removal of contamination go hand in hand, and no operator can afford to ignore either phase.

How to Detect and Cure Wire-Rope Troubles—I

First of two articles by A J Morgan, chief engineer, Wire-Rope Div, John A Roebling's Sons Co, shows what causes wire-rope difficulties and how to remedy them for long rope life

When a wire-rope engineer examines a rope installation he notes all the factors that may shorten its life and then looks for the contributing causes

► MANY USERS OF WIRE ROPE have said, "These rope engineers and manufacturers never admit there is anything wrong with their rope; it's always the fault of our machines." We agree that there is such a thing as bad wire rope. On the other hand, in the vast majority of rope complaints, it has been proved conclusively that certain minimum conditions, which are absolutely necessary to rope life, have not been maintained. Consequently, it is safe, when you tackle a problem of poor rope service, to assume that the rope would have given good service had it either been used on the job for which it was built or been given a fair break on the job it was called on to do.

Rope Inspections

Many wire-rope troubles would never occur if the owner of the machine understood the fundamentals of how to make an examination of his equipment, if he understood what the engineer does when he inspects a machine. There is nothing complicated about it, and it is an excellent idea, both for safety and in saving money, to make regular, thorough examinations.

The first thing an engineer remembers is that there are seven principal ways in which a wire (the fundamental unit of a wire rope) can be parted:

1. It can be cut through.
2. It can be pulled apart under tension.
3. It can be worn through by abrasion.
4. It can be eaten through by rust.
5. It can be broken in two by fatigue.
6. It can be twisted apart.
7. It can be mashed.

Consequently, when the rope engineer peers studiously at the individual broken wires, he is trying to establish which combination of the above factors has been responsible. This he can discover from the ends of the broken wires themselves, because each of the seven kinds of break will produce a different appearance in the cross-sectional view of the broken wire.

First, a wire cut through will be pinched down and bitten off, Fig. 2*F*. The ends of a wire broken under tension will be different from each other, one side of the break being cupped and the other coned, Fig. 2*A*. Where abrasion has broken a wire, the areas around the point of maximum abrasion will be highly polished, and in the case of crown wear in a rope wire, the broken ends will be worn down to knife-edge smoothness, Fig. 2*E*. Of course, a wire that has been corroded through can easily be identified by the pitted and rusted appearance; while a wire broken from fatigue, Fig. 2*C*, will be broken in a transverse manner and the ends will appear granular either to the naked eye, or preferably, aided by a glass.

Once having determined the factor at fault, the engineer's next step is to locate the cause of this factor. He makes a thorough study of your machine. It's nothing intricate. He merely

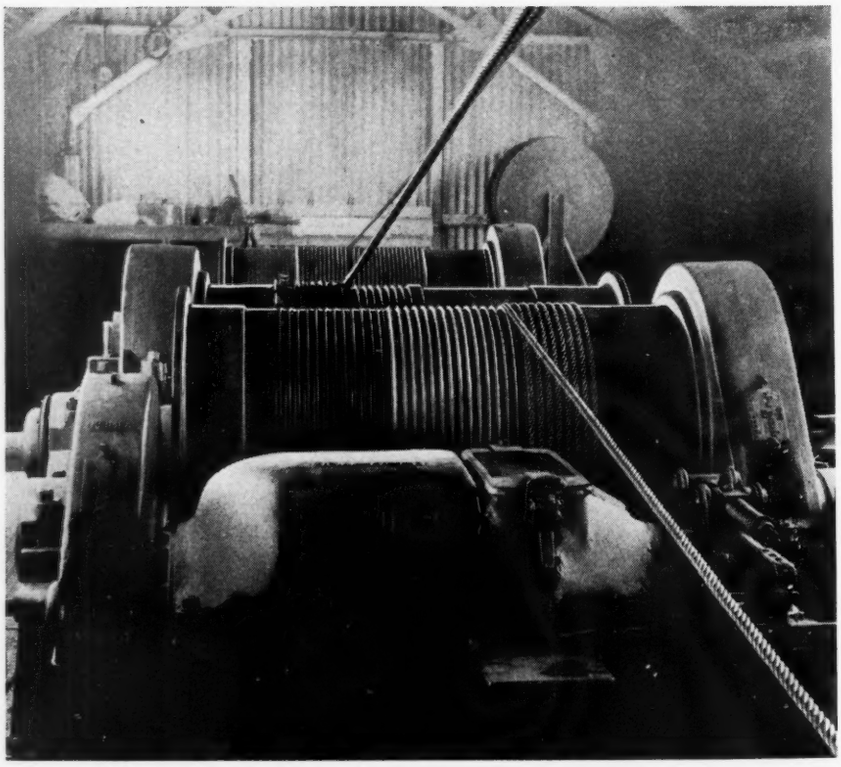
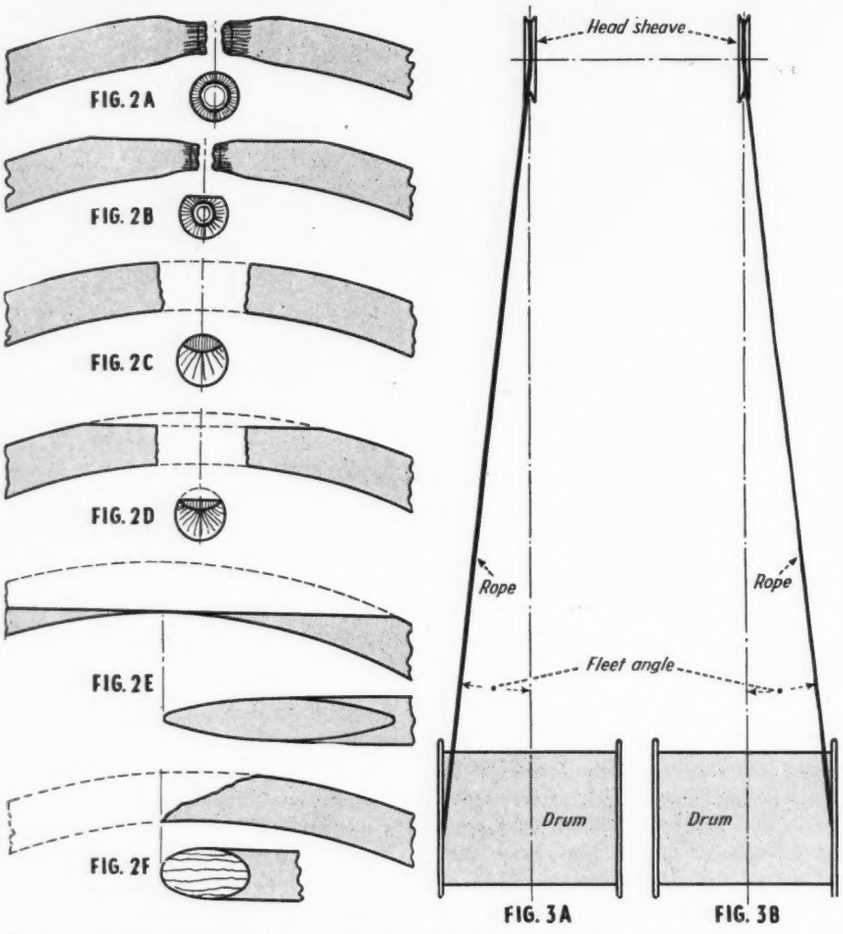


Fig. 1—The ropes must wind smoothly onto the drums without serious scrubbing of one wrap against another



Figs. 2*A* to 2*F*—Typical wire fractures: *A*—Cup and cone type, no abrasion. *B*—Cup and cone type with abrasion. *C*—Fatigue type, no abrasion. *D*—Fatigue type with abrasion. *E*—Worn completely through. *F*—Cut or gouged wire. Figs. 3*A* and 3*B*—Fleet angle when rope is in its two positions of greatest travel

checks to see whether a few fundamental working conditions are maintained, and if not, to what extent their absence has been responsible for the poor rope service.

Obviously, even with the right rope on the machine, the rope might break under tension if too heavy a lift is attempted. Thus, no further discussion is necessary on the subject of tension breaks, except to say that if other factors have weakened enough wires and strands, the rest may fail easily under strain of a normal load.

Drum Conditions

The engineer will examine the drum. Assuming that the right rope is on the machine, the drum diameter should be commensurate with the rope's construction. But, there is more to a drum examination than that. The surface must be checked. If it is grooved, are the grooves of the proper radius to accommodate the rope? Drum grooves are governed by the same rules as those for sheaves; this question will be discussed later.

The next question to settle: is the drum face uniform, or is there a high or low spot in its surface? If there is a high spot, the rope will tend to pile up away from the spot, towards the flanges. This will cause undue scrubbing of one wrap against the adjacent wrap as the drum winds. Conversely, if there is a low section, the rope will tend to pile up towards the bottom of that section, away from the flanges. There will then be undue scrubbing again of adjacent wraps as the rope winds on the drum.

Fleet Angle

Next, we come logically to an examination of the "fleet angle". This term should not, but does, frighten some rope users. The fleet angle is simply that angle between the center line of the "lead" sheave and the rope, Figs. 3*A* and 3*B*. The lead sheave is the first sheave over which the rope passes as it winds from the drum.

The fleet angle must be kept within certain limits. If it exceeds 1.5 deg, the rope may wind unevenly, crowding and scrubbing in spots, and winding loosely in others. A large fleet angle will also cause the rope to scrub against the flanges of the lead sheave, adding another source of abrasive wear. Again, if the angle is less than 0.5 deg, the rope may wind unevenly if more than one layer of rope is used.

Of course, these conditions are ideal. Occasionally, in the interest of economy or practical machine design, they must be violated to some extent.

It is important to the life of a rope

that it be wound evenly on the drum. This objective is usually reached by having the proper fleet angle. On the other hand, normal care must be taken that the rope originally is wound tightly and in close wraps. Care must be taken also that there is always sufficient tension on the rope, when a load is released. If this is not done, the natural elasticity of the rope will snap back to the drum and cause a misarrangement of the wraps, thereby producing conditions of pile-up and crushing.

Even under normally good drum-winding conditions, there will frequently develop a condition of sectional wear in a rope which winds in multiple layers. Such wear is not, as is sometimes claimed by the inexperienced, caused by a series of "soft spots" in the rope. It is probably occurring at the "cross-over" points or the layer-starting point.

Cross-Over Points

The cross-over point is that point at which the rope of the on-coming layer crosses over the rope on the layer below, Fig. 4. This occurs when the rope is forced, by the wrap next to it, out of the groove formed by two adjacent wraps on the lower layer in which it has been winding. It must then climb over the crest of one of the bottom wraps before becoming engaged in the next groove. The top rope crosses two wraps of the underneath layers in this manner for every revolution of the drum. It is at the spots where this action takes place that constant abrasive action and consequent concentrated wear occur on the rope.

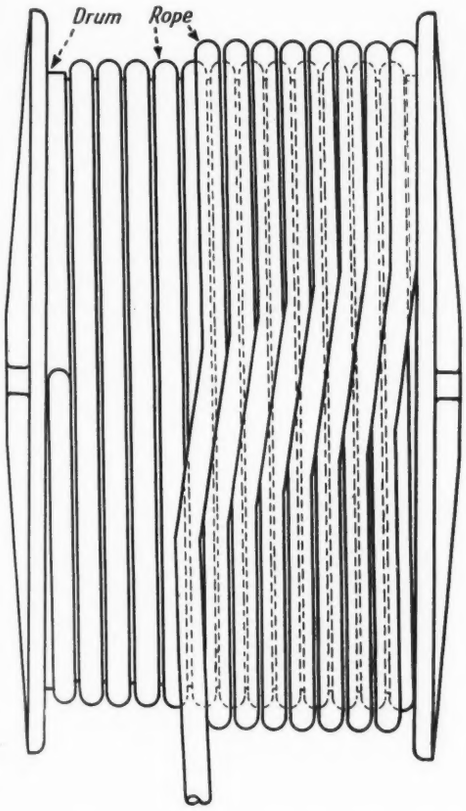
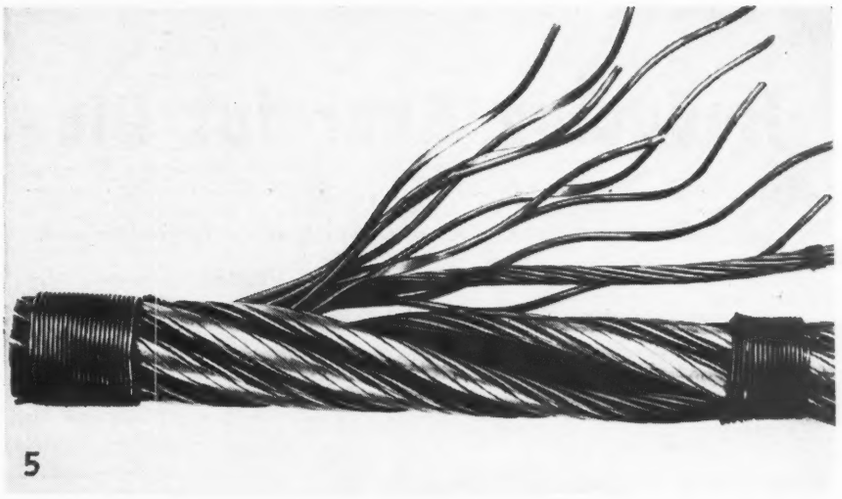
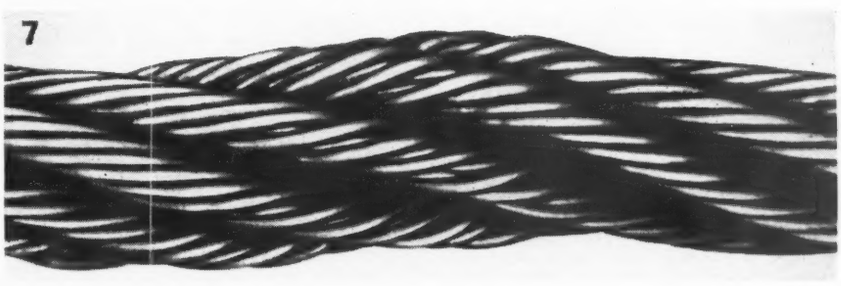


Fig. 4—Constant abrasion takes place where the rope wraps of the top layer cross those of the lower layer

Another somewhat similar instance of concentrated abrasion found in normal multiple-layer winding occurs at the point where the on-coming layer is filled and the rope is pushed up to start a new layer. After the first wrap of the new layer is wound, the on-coming rope will strike the point at which the layer was started and be shunted over acutely, as in Fig. 4. At this point abrasion and scrubbing on the surface wires of the rope will be high.

The remedy for these conditions is to unwind the rope occasionally and cut off a piece at the drum end equal in length to 1.25 or 1.75 times the diameter of the drum. In this way, the cross-over points and layer-starting points are changed and the wear is distributed among several different sets of points along the rope instead of concentrating only in one. By all means do not remove a multiple of the drum diameter, because, if such a length is cut, old cross-over and layer-starting points will fall adjacent to each other again and wear will continue at these places.





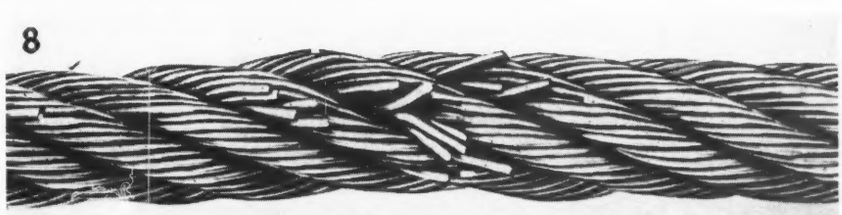
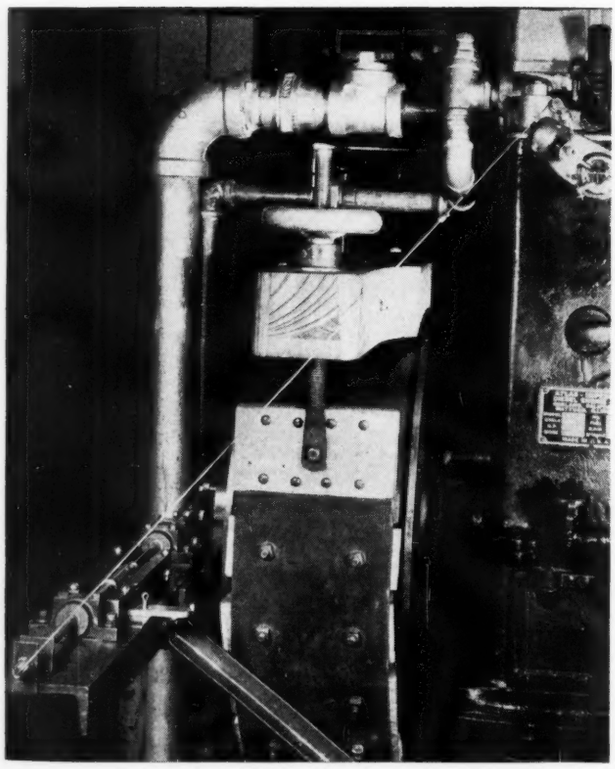


Fig. 5—Although badly worn on the outside, this rope shows no serious effects from service on the inside because it was well lubricated. Fig. 6—Broken wires, not wear, caused this rope to be condemned. Fig. 7—Once a rope has been kinked the distortion cannot be removed completely and early failure is in prospect. Fig. 8—Broken wires in this rope resulted from a kink during installation

Reducing Gear for Diesel Indication

Simple detent motion developed at Pratt Institute, Brooklyn, N. Y., proves convenient and accurate at engine speeds in excess of 1000 rpm



Detent motion installed on single-cylinder diesel engine in Pratt Institute mechanical laboratory

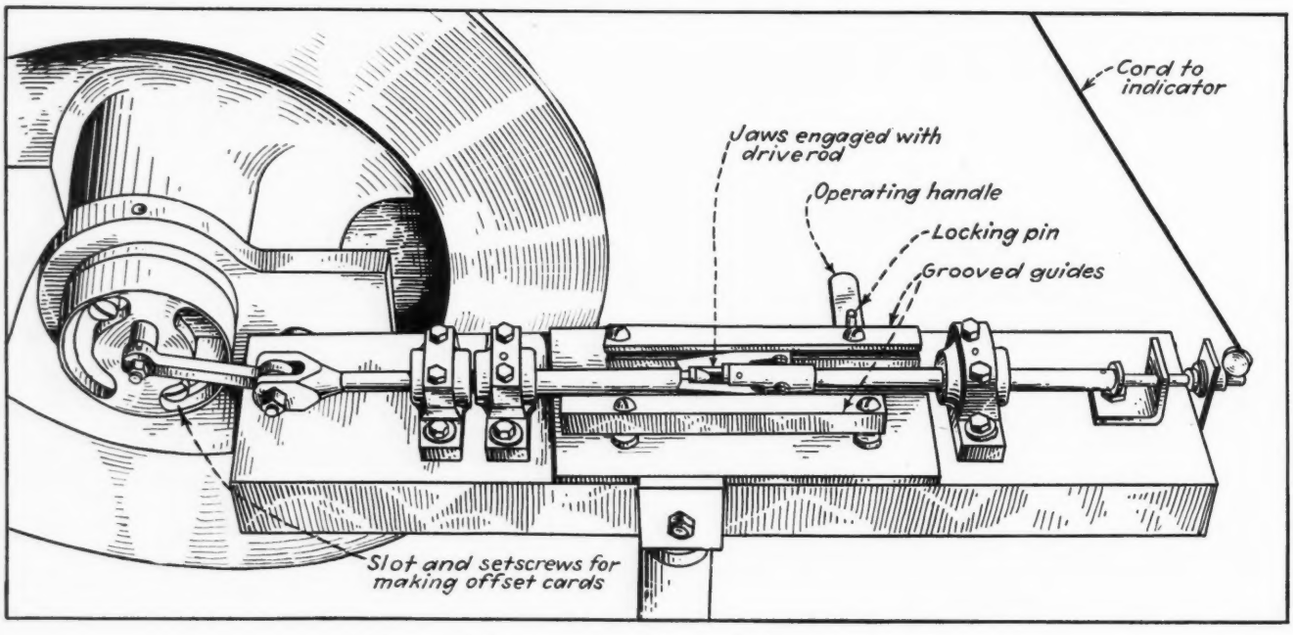
▶ AT THE BEGINNING of a research program on problems of high-speed diesel indication, members of the Pratt Institute (Brooklyn) staff found they needed a low-cost, easily constructed reducing gear that would give accurate results at engine speeds in excess of 1000 rpm. Under direction of Dr Frank L. Schwartz, a detent motion was built.

The photo and perspective drawing show the motion installed on a single-cylinder diesel in the Institute's mechanical laboratory. Bearings at the left carry a "drive" rod connected by a crank to the main shaft. The ratio of this crank-connecting-rod combination is the same as that in the engine. Slotted holes in the connection to the engine shaft permit changing the phase of the indicator relative to the piston, enabling offset cards to be taken.

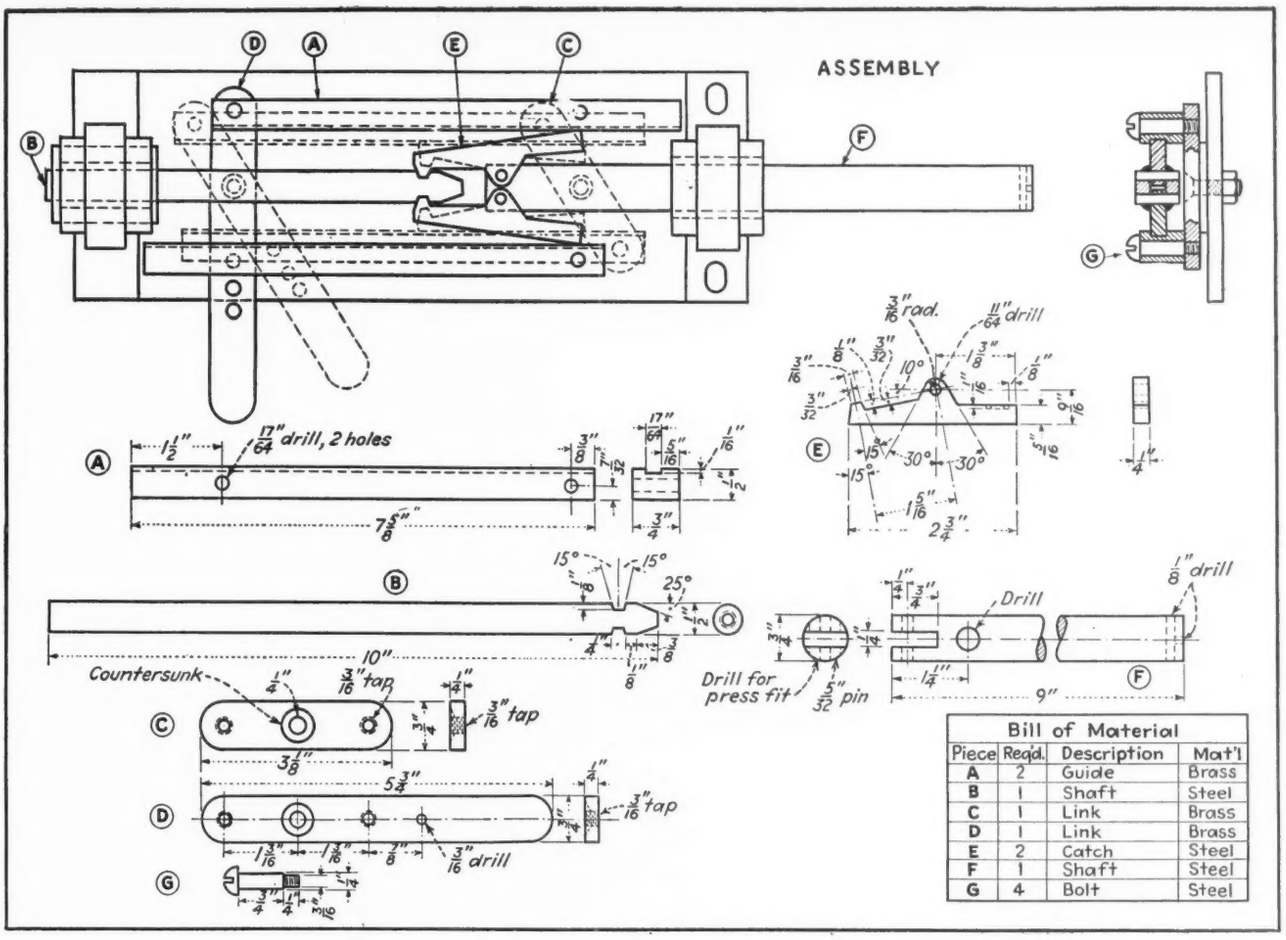
Construction of Indicator

A bearing at the right end carries another rod which is connected by a string, running over a pulley, to the indicator mounted on the cylinder block. This latter rod carries a pair of pivoted jaws with a coil spring to force the jaws together. These jaws slide in the groove of a pair of parallel horizontal guides. Two parallel bars, pivoted on the centerline of the rods, connect the guides in such a fashion that when the bars stand at right angles to the guides, the space between the guides is greater than when the bars form an acute angle with the guides. One bar is longer than the other, forming a handle; this bar can be locked in either position.

The method of operation can be seen clearly by referring to the perspective drawing. Normally, the bar is in the angular position, bringing the guides close enough together to force



Closeup of detent motion shows principle of operation


ASSEMBLY
17/64" drill, 2 holes
3/16" rad.
11/64" drill
Countersunk
3/16" tap
Drill for press fit
5/32" pin
Drill
1/8" drill
Bill of Material
Piece | Reqd. | Description | Mat'l
A | 2 | Guide | Brass
B | 1 | Shaft | Steel
C | 1 | Link | Brass
D | 1 | Link | Brass
E | 2 | Catch | Steel
F | 1 | Shaft | Steel
G | 4 | Bolt | Steel

Working drawing for reducing gear employing detent motion

the jaws apart and allow the drive rod to run free. The rod carrying the jaws is held at the end of its stroke by the tension of the indicator-drum spring.

To take a card, the operator moves the handle to the right-angle position shown in the drawing, moving the guides apart and thus permitting the jaws to close, catching the notched end of the drive rod. The motion of the piston is thus transmitted, in accurate ratio, to the indicator. Taper of jaw and slot compensates for wear, insuring maintenance of the tight fit.

The actual motion shown in the photo and drawings was built to take a 4-in. card, to meet particular needs of the Pratt Institute laboratories. If designed solely for taking the conventional 1½-in. card, the over-all size of the mechanisms could be cut in half. Naturally, a reducing mechanism of this kind can be used on any reciprocating machine.

✦ ✦ ✦

Stress Calculation for High-Temperature Piping—II

Last month Mr Spielvogel explained the calculation of end reactions. Here he presents the corresponding solution for pipelines containing circular quarter bends

▶ JUST AS FOR PIPING joined by short-radius elbows or welding fittings, the approach to calculating end reactions requires first projecting the line into three planes of a right-angled coordinate system with positive axes assumed in the direction of the anticipated end reactions, that is, opposite to the expansion. In calculating the centroid of each projection, the length of certain branches must be modified to account for (1) the difference between the modulus of rigidity in torsion and the modulus of elasticity in bending and (2) the added flexibility due to flattening of curved branches.

In reference to (1), members that do not appear in true length, when projected, are subjected to torsion. Thus a straight branch appearing as a point in the projection is multiplied by 1.3. A quarter bend, shown in projection as a dotted line, is multiplied by 1.15.

In reference to (2) flattening is accounted for by multiplying the length of the curved portion by the so-called flexibility constant (also known as rigidity multiplication factor K) but this applies only in that plane in which the bend appears in its true length. The value of K depends on the mean radius of the pipe, its wall thickness

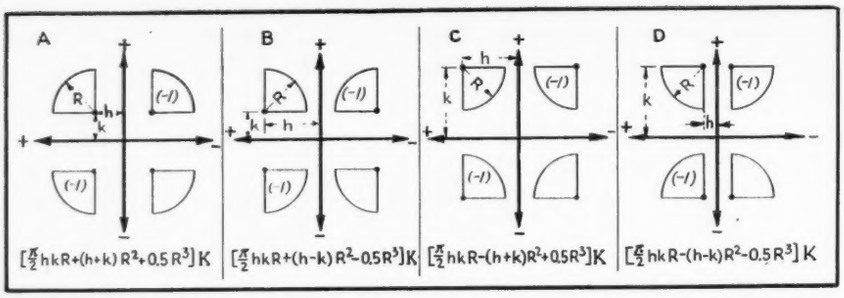


Fig. 1—Product of inertia for quarter bends located in plane of projection. Introduce coordinates *h* and *k* of center of circle *numerically*. Multiply result by (—1) if position of quarter bend calls for it as indicated above

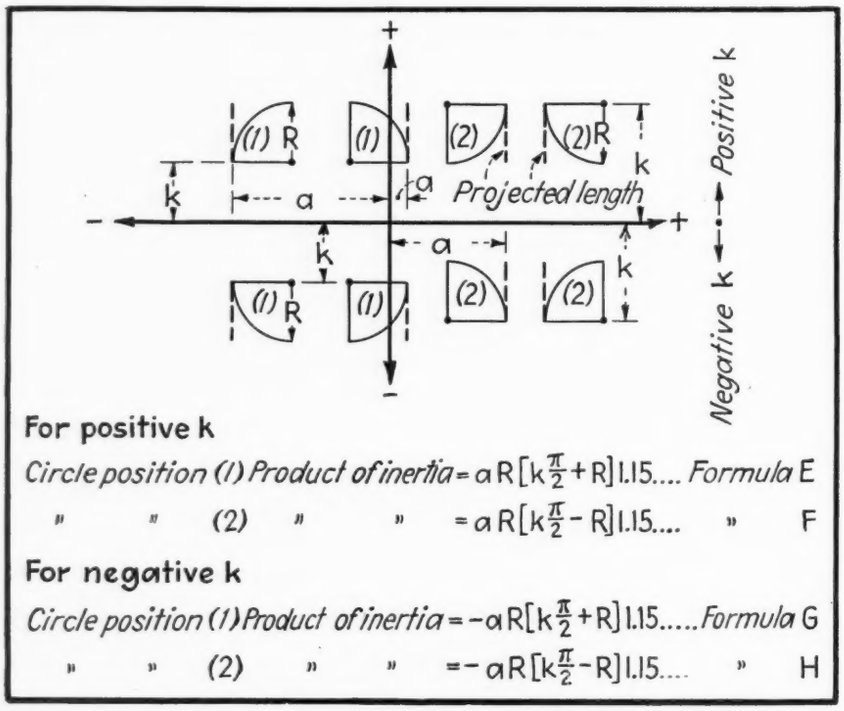


Fig. 2—Product of inertia of quarter bend located at right angles to plane of projection. Introduce *a*, *R*, and *k* numerically and multiply the result by the sign of *a*

and the radius of curvature of the bend. It is calculated from the formulas given at top of the numerical problem, Fig. 4.

As an example for computing modified lengths, refer to Fig. 4 for the projection in the *xy* plane of the straight branch *ef* which appears as a point. Its modified length is 1.3 × 48 in. = 62 in.

Quarter bend *de* appears as a dotted line. Its modified length is 60-in. × $\frac{\pi}{2}$ × 1.15 = 108 in. On the other hand, quarter bend *bc* appears in its true length but must be modified to account for flattening. With $K = 2$ (see top of Fig. 4) its modified length is 60-in. × — × 2 = 189 in.—$\frac{\pi}{2}$ × 2 = 189 in.

The next step is calculating the centroid of the projected system. For better visualization, quarter bends which appear in reduced length (dotted) are also shown revolved 90 degrees as for instance *de* in the *xy* plane. The dimension 21.8 locating the centroid of *de* is obtained from Fig. 4a.

Having determined the centroid of the three projections, we proceed to calculate the product of inertia. For quarter bends located in the plane of projection, refer to the formulas of Fig. 1. For bends located in planes at right angles to the plane of projection, refer to the formulas of Fig. 2.

Example 1: Quarter bend *bc* in *xy* plane appears in true length. The coordinates of its center are $h = 51.7$, $k = 40.65$, and the position of the circle in reference to the axes calls for formula *D* of Fig. 1. Thus

$$I_{xy} = [\frac{\pi}{2} 51.7 \times 40.65 \times 60 - (51.7 - 40.65)\ 60^2 - 0.5 \times 60^3]\ 2 = 100{,}584$$

Example 2: Quarter bend *de* in *xz* plane appears in projection as indicated by dotted line. Its projected length is parallel to the *z* axis. The distance of the dotted line from the axis parallel to it is designated by the letter *a* which is the abscissa for all points of the bend. The ordinate of the center of the circle is designated by the letter *k*. For *de*, $a = -17.95$, $k = -47.5$.

Referring to Fig. 2, negative *k* and circle position (2) call for formula H. The values of *a*, *R*, and *k* are introduced in this formula numerically and the result multiplied by —1 because *a* is negative. Thus

$$I_{xz} = (-1)\ (-17.95 \times 60)\ \frac{\pi}{2}\ 47.5 - 60)\ 1.15 = 18{,}090$$

The last group of constants to be calculated is that which signifies the moment of inertia of the line. For quarter bends, refer to formulas of Fig. 3. Note that quarter bends appearing in true length are modified by the flexibility constant *K* and those appearing in reduced length by the 1.15 to account for the torsional effect.

Fig. 4—Form for orderly computation of completely worked out numerical example of piping system having circular quarter bends

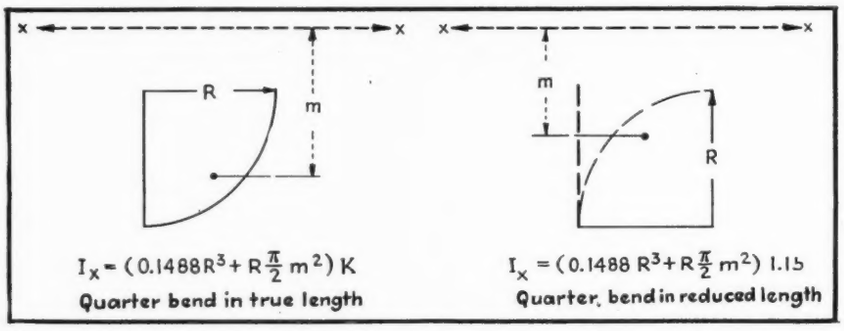
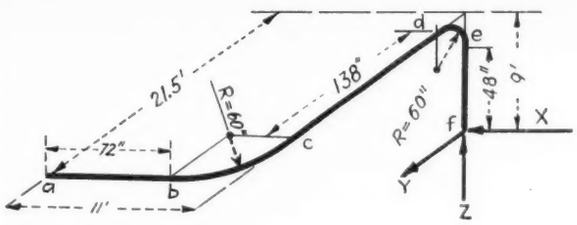


Fig. 3—Moment of inertia of quarter-bend in respect to reference axis



X, Y, Z..... reactions and directions of positve x, y, z axes

12"pipe Wallthickness $t = 0.5"$ $I = 361.5 in^4$

Temp 725 F Expansion 5.88"/100 ft

$\Delta X = 11' \times 0.0588 = 0.647"$
$\Delta Y = 21.5' \times 0.0588 = 1.27"$
$\Delta Z = 9' \times 0.0588 = 0.53"$

For working temperature of 725 F..... $E = 25 \times 10^6$ lbs/in²

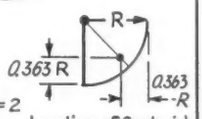
$\Delta x\ EI = 5,847 \times 10^6$
$\Delta y\ EI = 11,477 \times 10^6$
$\Delta z\ EI = 4,790 \times 10^6$

OD = 12.75"

Mean radius of pipe r = 6.125"

Radius of bend R = 60"

$$\lambda = \frac{tR}{r^2} = \frac{0.5 \times 60}{6.125^2} = 0.8$$



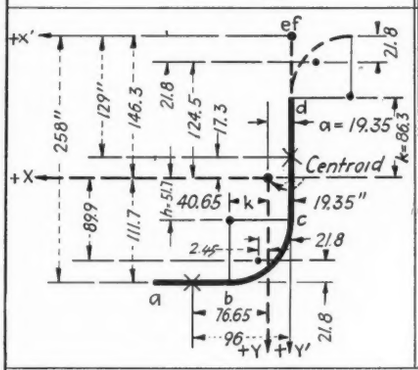
Location of Centroid

$$\text{Flexibility constant } K = \frac{12\lambda^2 + 10}{12\lambda^2 + 1} = 2$$

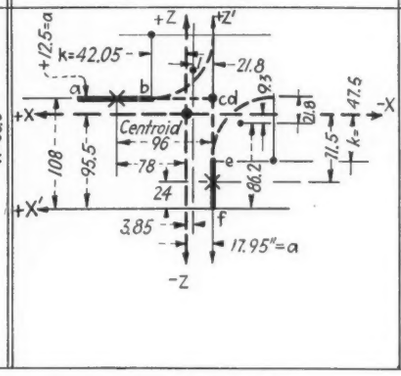
Fig. 4A

PROJECTION IN

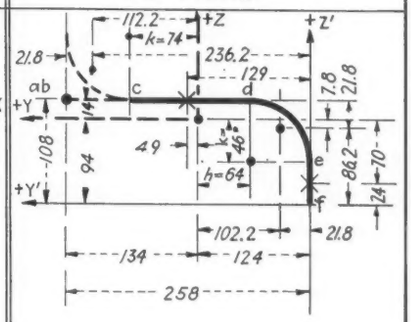
XY - Plane



XZ - Plane



YZ - Plane



CENTROID

	Length l	x'	lx'	y'	ly'
ab	72	96	6,912	258	18,576
bc	$\frac{\pi}{2}RK$ = 189	21.8	4,111	236.2	44,589
cd	138	0	0	129	17,800
de	$\frac{\pi}{2}R \times 1.15$ = 108	0	0	21.8	2,360
ef	48 x 1.3 = 62	0	0	0	0
	569		11,023		83,325

$\bar{X} = \frac{11023}{569} = 19.35"$ $\bar{Y} = \frac{83325}{569} = 146.3"$

	Length l	x'	lx'	z'	lz'
ab	72	96	6,920	108	7,780
bc	$\frac{\pi}{2}R1.15$ = 108	21.8	2,360	108	11,680
cd	138 x 1.3 = 179	0	0	108	19,350
de	$\frac{\pi}{2}R1.15$ = 108	0	0	86.2	9,360
ef	48	0	0	24	1,150
	515		9,280		49,320

$\bar{X} = \frac{9280}{515} = 17.95"$ $\bar{Z} = \frac{49320}{515} = 95.5"$

	Length l	y'	ly'	z'	lz'
ab	72 x 1.3 = 94	258	24,100	108	10,100
bc	$\frac{\pi}{2}R1.15$ = 108	236.2	25,600	108	11,700
cd	138	129	17,800	108	14,910
de	$\frac{\pi}{2}RK$ = 188	21.8	4,100	86.2	16,260
ef	48	0	0	24	1,150
	576		71,600		54,120

$\bar{Y} = \frac{71600}{576} = 124$ $\bar{Z} = \frac{54120}{576} = 94$

I_{xy}

	Formula		
ab	l x y	72 x 76.65 x 111.7 =	+ 616,450
bc	"D"	k = 40.65, h = 51.7	+ 100,584
cd	l x y	138 x (-19.35)(-17.3) =	+ 46,196
de	"G"	a = 19.35, k = 86.3	+ 261,120
ef	l x y	62 x (-19.35)(-146.3) =	+ 176,648
			I_{xy} = 1,200,998

I_{xz}

	Formula		
ab	l x z	72 x 78 x 12.5 =	+ 70,200
bc	"F"	a = 12.5, k = 42	+ 5,218
cd	l x z	179 x (-17.95) 12.5 =	- 40,250
de	"H"	a = 17.95, k = 47.5	+ 18,090
ef	l x z	48 x (-17.95)(-71.5) =	+ 61,600
			I_{xz} = +114,858

I_{yz}

	Formula		
ab	l y z	94 x 134 x 14 =	+ 175,500
bc	"E"	a = 14, k = 74	+ 170,000
cd	l y z	138 x 4.9 x 14 =	+ 9,480
de	"D"	h = 64, k = 46	+ 209,680
ef	l y z	48 x (-10)(-124) =	+ 417,000
			I_{yz} = + 981,660

I_x and I_y

I_x	ab	72×111.7^2	= 898,336
	bc	$(0.1488 \times 60^3 + 60\frac{\pi}{2} \times 89.9^2)$ *)2 =	= 1,584,360
	cd	$\frac{138^3}{12} + 138 \times 17.3^2$	= 260,400
	de	$(0.1488 \times 60^3 + 60\frac{\pi}{2} \times 124.5^2)1.15$ =	= 1,719,897
	ef	62×146.3^2	= 1,335,000
		*) K = 2	I_x = 5,797,993
I_y	ab	$\frac{72^3}{12} + 72 \times 76.65^2$	= 455,200
	bc	$(0.1488 \times 60^3 + 60\frac{\pi}{2} \times 24.5^2)2$ =	= 65,470
	cd	138×19.35^2	= 51,700
	de	108×19.35^2	= 40,400
	ef	62×19.35^2	= 23,100
			I_y = 635,870

I_x and I_z

I_x	ab	72×12.5^2	= 11,220
	bc	108×12.5^2	= 16,900
	cd	179×12.5^2	= 28,000
	de	$(0.1488 \times 60^3 + 60\frac{\pi}{2} \times 9.3^2)1.15$ =	= 46,400
	ef	$\frac{48^3}{12} + 48 \times 71.5^2$	= 254,700
			I_x = 357,220
I_z	ab	$\frac{72^3}{12} + 72 \times 78^3$	469,200
	bc	$(0.1488 \times 60^3 + 60\frac{\pi}{2} \times 38.5^2)1.15$ =	= 38,600
	cd	179×17.95^2	= 57,800
	de	108×17.95^2	= 34,900
	ef	48×17.95^2	= 16,750
			I_z = 617,250

I_y and I_z

I_y	ab	94×14^2	= 18,300
	bc	108×14^2	= 21,280
	cd	138×14^2	= 21,050
	de	$(0.1488 \times 60^3 + 60\frac{\pi}{2} \times 7.8^2)2$ *) =	= 75,800
	ef	$\frac{46^3}{12} + 48 \times 70^2$	= 244,200
		*) K = 2	I_y = 386,630
I_z	ab	94×134^2	1,675,000
	bc	$(0.1488 \times 60^3 + 60\frac{\pi}{2} \times 112.2^2)1.15$ =	= 1,400,000
	cd	$\frac{138^3}{12} + 138 \times 4.9^2$	= 222,320
	de	$(0.1488 \times 60^3 + 60\frac{\pi}{2} \times 102^2)2$ =	= 2,032,360
	ef	48×124^2	740,000
			I_z = 6,069,680

Sum of $I_x = 5,797,993 + 357,220 = 6,155,213$
$I_y = 635,870 + 386,630 = 1,022,500$
$I_z = 617,250 + 6,069,680 = 6,686,930$

$$6,155,213X - 1,200,998Y - 114,858Z = 5,847 \times 10^6$$
$$-1,200,998X + 1,022,500Y - 981,660Z = 11,477 \times 10^6$$
$$-114,658X - 981,660Y + 6,686,930Z = 4,790 \times 10^6$$

X = 5090 lbs Y = 20,900 lbs. Z = 3,860 lbs

Reacting couples at "f"

in xy-plane: $-5090 \text{ lbs} \times 146.3" - 20,900 \text{ lbs} \times 19.35" = +340,200 \text{ in lbs}$

in xz-plane: $-5090 \text{ lbs} \times 95.5" + 3,860 \text{ lbs} \times 17.95 = -416,800 \text{ in lbs}$

in yz-plane: $-20,900 \text{ lbs} \times 94" + 3,860 \text{ lbs} \times 124" = -1,486,000 \text{ in lbs}$

THE OLD CHIEF

IV—Comforting the Engineer

Fourth in a series of reminiscences by William Doran, chief engineer, Essex County Sanatorium, Windsor, Ontario. Writing of the inspiration of the past, he has captured much of the human side of engineering that lies beneath the maze of power-plant costs and the wavy lines on paper disks

▶ EARLY LAST YEAR I was present at the opening of a cafeteria built solely for the convenience of the employees. I saw a picture of polished steel, replete with every modern convenience for serving meals "to the queen's taste." I noticed the engineers there, all as clean as bank clerks, and I thought of other days and other meals.

I recalled the first meal I ever ate at the old plant. We washed our hands in a pail with the help of a little boiler compound and heated our tea can over the blacksmith's fire. We then fished out our lunch boxes and squatted on a coal barrow, an upturned pail or the grimy floor, and, mark you, thoroughly enjoyed our meal. Later on we commandeered an unused shed at the rear of the plant to which we added, as time went on, and at our own expense, tables, benches, a gas stove and for winter a gas heater.

Sandwich Barter

Speaking of lunches, I wonder if housewives are aware of the commodity value of the sandwiches they place in their men folks' lunch boxes, or of the seasonable fluctuations in the sandwich market. I can remember that in our first real lunch room the barter in sandwiches was often quite lively, and it may surprise some good ladies to know that one salmon sandwich will buy two plain pork or beef and that a pale off-season tomato sandwich has very little trading value. Those dinky little bridge-club sandwiches have no commodity value; in fact, they are not considered legal tender.

Many were the jokes made regarding the contents of the lunch boxes. One fellow whom we called Tony used to carry his lunch in an ample-sized basket. He was an uncooked-food fadist and lived off raw carrots, big Spanish onions, cucumbers, etc. One day our Irish timekeeper poked his head into the door. "Tony," he said, "I'll be asking ye to close the lid of that portmanteau of yours, not that I've any objection to what ye eat, but a lady two blocks away has phoned a complaint regarding the smell coming from this plant."

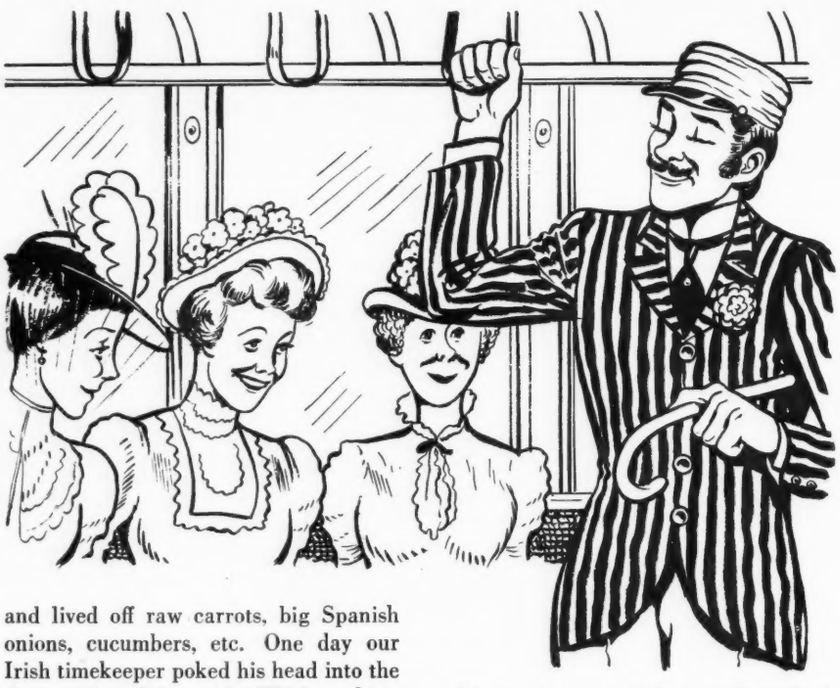
Our first shower was a very unprivate contrivance in a corner of the pump room. It consisted of a perforated iron pail hung high with a hose leading to it. It was quite unsanctioned and could be used only by the afternoon and night shifts.

Beau Brummel

All this desire for cleanliness on the part of the "black squad" brought a change in the old custom of men coming and going from work in their overalls. I recall one little man who developed into quite a dandy; he would come to the power house in tennis slacks and everything to match, including a panama hat with a large red and white diagonal-striped band.

One day after a tube-punching session, he dressed to go home with his usual care, but on leaving he absent-mindedly placed his dilapidated and begrimed work cap on his head instead of his cherished panama, and sallied forth. He was impressed by the way all the young ladies in the street car smiled at him, and it was only when he attempted to tip his hat in a very polite salute to a particular lady friend, that he discovered the reason for all the smiling faces.

If I were asked to picture the average plant engineer at the turn of the century, I would describe a man, tall, thin and poker-faced, so methodical in his habits that you could set your watch by his actions, a good listener but very hard to draw into conversation, a man at all times willing to pass on to younger men the helpful benefit of his experience or study.



"Impressed by his lady friend's smiles"

His ears attuned to every single noise in a bedlam of noises, just as the leader of an orchestra will spot an off-pitch note, so would the engineer pick up and locate a warning sound in the general hubbub of the engine room. They tell a story of Dougal McClink, a marine engineer on a coastal trader, who claimed he could sleep like a baby on his off watch, just as long as the engines sang "Dougal-Ma-Clink, Dougal-Ma-Clink." But if he ever heard them say "Clink-Mac-Dougal," he knew hell was popping in the engine room.

Mechanical Power Transmission

By F A ANNETT
Associate Editor

THE POWER ENGINEER'S RESPONSIBILITY in modern industry is *delivered power* in all its forms. His job is to buy power or make it (whichever is cheaper), transmit it around the industrial establishment and deliver it to the productive machines.

Mechanical power transmission is a major element in this picture—far more important than commonly realized.

One common misconception, in this "age of electricity", is the assumption that power transmission simply means electrical transmission. The fact is that completely electrical transmission of power right up to the working point is almost unheard of, except in electrical heating and electrolytic processes. Except where transmission is entirely mechanical, the standard modern arrangement is electrical and mechanical elements linked in this order: conductor, motor, mechanical transmission, production machine.

It is impossible to eliminate the third step, except where a circular saw, or similar working device, is fastened directly to the motor shaft. Even the so-called "direct motor drive" requires a coupling—the simplest element of mechanical power transmission.

More often than not a coupling, by itself, is not enough for a sound engineering job because a direct-coupled motor implies one of three things: either (1) the motor does not run at its best speed, (2) the driven machine does not run at its best speed, or (3) the designer has been favored by an "Act of God", in that best machine speed happens to be the best motor speed.

The mere fact that motors may be had in a whole series of synchronous speeds does not avoid the limitation of so-called "direct drive", because every step down in motor speed is a step up in motor cost. That's why almost every "completely motorized" plant contains scores or hundreds of speed-ratio drives requiring belts, ropes, gears, chains or variable-speed transmissions to operate a machine at one speed from a motor at another.

Thus the transmission commonly has at least two jobs, transmitting power and changing rpm. Generally it must serve also to bridge the physical gap between the most convenient locations of motor and driven shaft. Nor is that all: it is always possible, and often necessary, to assemble a combination of transmission elements that will transfer power from a shaft running at one speed to another in a different place, set at a different angle and running at a different and variable speed—also to provide a shock-absorbing "cushion" between driver and driven.

Every case is special, and the engineer must decide which of these results he wants and what elements, how assembled, will do the job effectively at reasonable cost. His working kit is a series of standardized transmission devices easily arranged in a variety of combinations—couplings, flat and V-belts with their pulleys and sheaves, reducing-gear sets, chains, variable-speed transmissions and gearmotors. These are the elements he must understand, both in their modern commercial forms and in terms of their mechanical principles.

Fortunately there is little mystery in this entire business of mechanical power transmission. It's mostly horse sense. For that reason, and because POWER's aims are always practical, the editors take particular pleasure in presenting this 16-page special section.

The power engineer will find here a matter-of-fact presentation, free from technicalities because none are needed for a practical understanding. Most of the equipment pictured will be familiar to the POWER reader, but the section will help him see more clearly the special uses and limitations of each type.

Flexible Couplings

A RIGID COUPLING would be the ideal connection between two shafts, if they could be kept in perfect alignment. But, even after they are properly aligned, there is no certainty they will stay that way. Foundations distort, bearings wear, temperatures may vary widely at different bearings along a shaft, and other factors all tend to produce misalignment. Thus, the need for flexible couplings.

There are three conditions of misalignment: parallel, angular and a combination of the two, for which a flexible coupling must compensate. Radial or parallel misalignment is indicated in Fig. 1. Here the shafts axes are parallel but their axes do not fall on the same straight line. In this case, the faces of the two halves of the coupling are parallel, but their outer circumferences are not in the same circle.

Angular misalignment is shown in Fig. 2. Here the axes of the shafts are not parallel; consequently, the coupling faces form an angle between them. The most common form of misalignment is a combination of these two, a condition shown in Fig. 3. Any flexible coupling should compensate for a small amount of misalignment, that is, have radial and angular flexibility.

Axial Flexibility

A flexible coupling may also have axial and tangential flexibility. The first permits a certain amount of end float of the shafts, which most couplings will do. Tangential flexibility permits a momentary rotational movement of one half of the coupling relative to the other. Many couplings possess this quality which makes it possible for them to absorb sudden load shocks, to a certain degree.

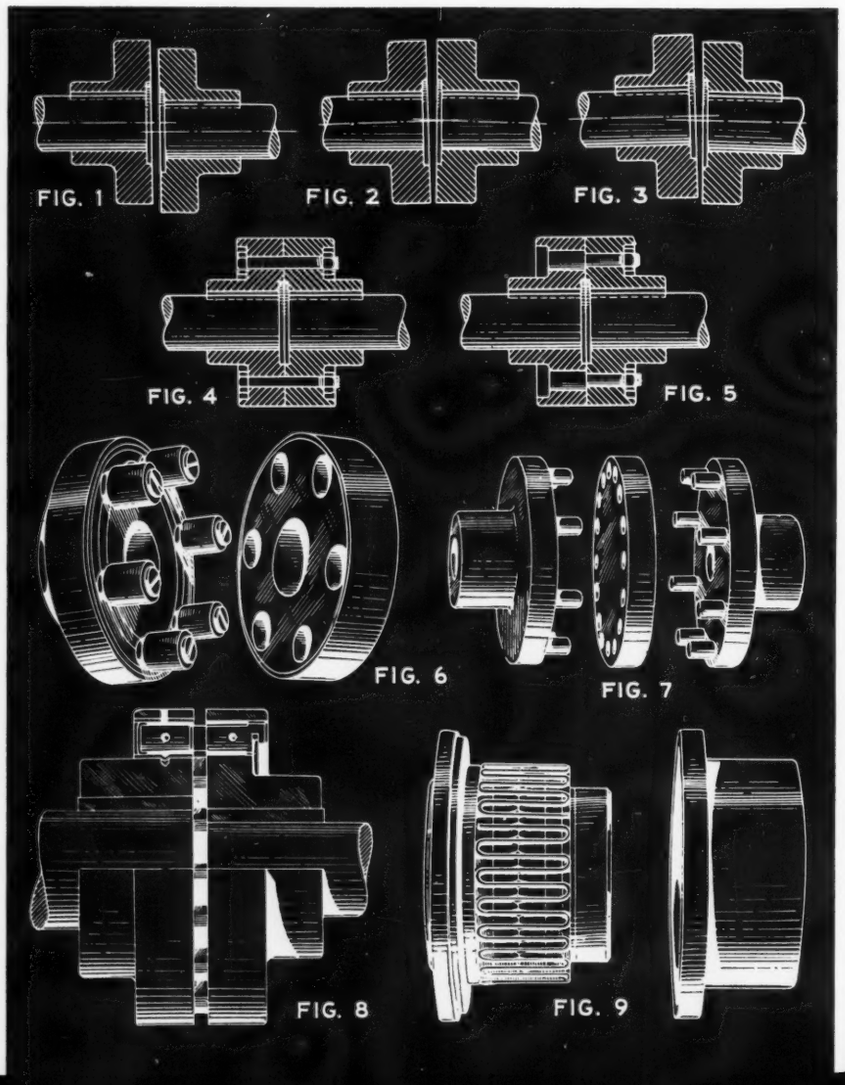
Designs of flexible couplings are more numerous than the famous 57 varieties, but they all fall within a few classes. Many of them are a modification of the rigid-flange type. Fig. 4. If the coupling bolts, Fig. 4, were replaced by pins fixed in one flange and extending into clearance holes in the other, Fig. 5, such a design would have a certain amount of flexibility. Many flexible couplings are a modification of this idea and include means to make them more flexible, reduce wear on the pins and holes and make them operate quietly.

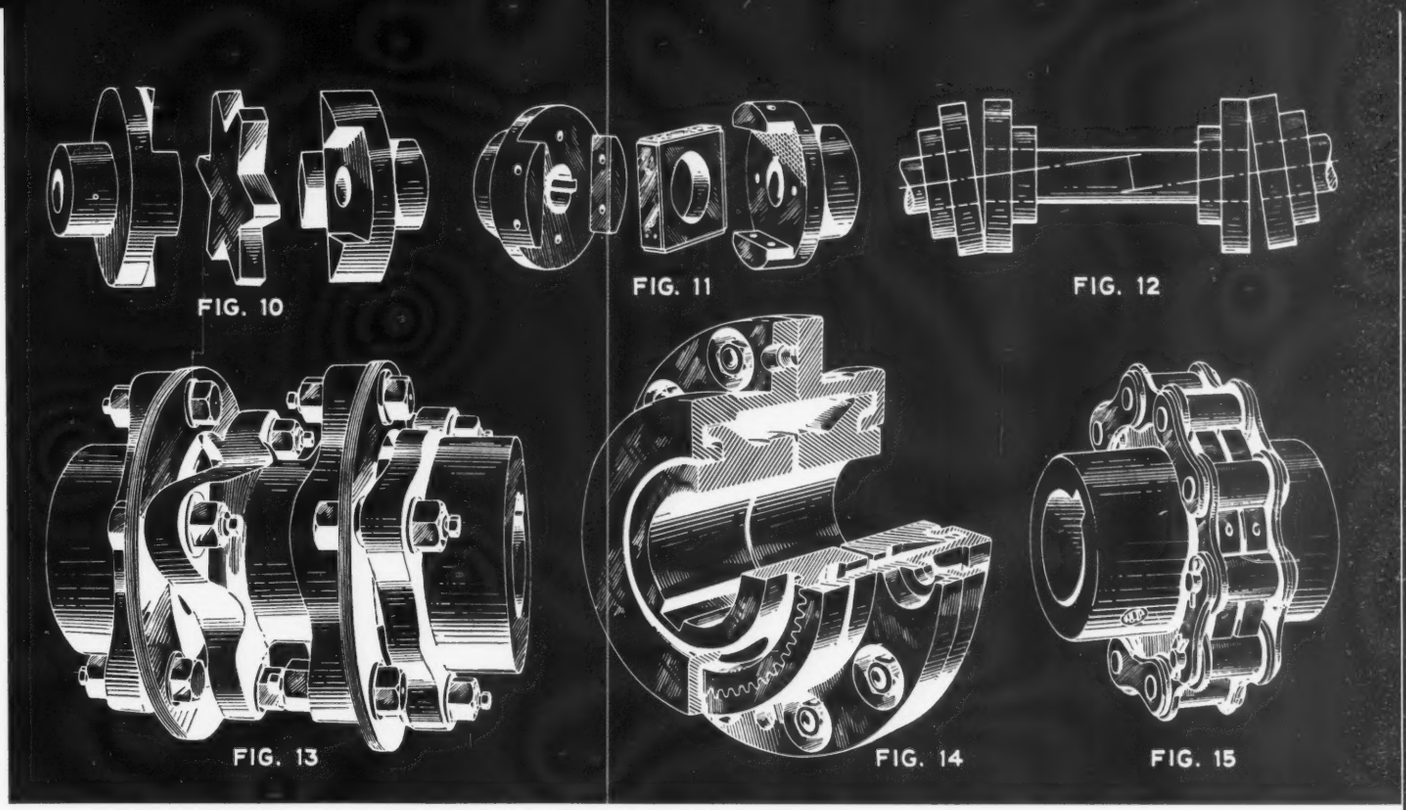
A coupling of this type, Fig. 6, uses special rubber bushings vulcanized onto the pins. These pins are held rigidly in one half of the coupling and the bushings fit snugly into holes in the other half. In other designs, instead of putting the bushing on the pins they are put into the holes in each half of the coupling. In still other types, pins are fixed in both halves of the coupling and fit into holes in a rubber, leather, or fibre disk between the two halves, as shown in Fig. 7.

This design is available in several forms. One has an endless leather belt interwoven between the pins. Another uses endless ropes interwoven between the pins for the flexible member. Still others use leather, rubber, or metal links to connect the pins in one half of the coupling to those in the other half. These designs are very flexible, permit end float of the shafts and prevent shocks from being transmitted from the load to the driving medium.

In the coupling, Fig. 8, the pins are made in two sections connected by a laminated-steel flexible member. One end of the pins is free to move endwise in bronze or graphite bushed holes in one half of the coupling. In the other

Fig. 1—Parallel misalignment. Fig. 2—Angular misalignment. Fig. 3—Combination parallel and angular misalignment. Fig. 4—Rigid coupling. Fig. 5—Rigid coupling modified to be flexible. Fig. 6—Flexible coupling with rubber-covered pins. Fig. 7—A non-metallic disk is the flexible element in this coupling. Fig. 8—This coupling has flexible metal pins. Fig. 9—An all-steel coupling with a spring grid for the flexible element





Figs. 10 and 11—Two designs of jaw-type flexible coupling. Fig. 12—Two-flexible-coupling arrangement to take care of excessive misalignment. Fig. 13—Double-engagement flexible-disk coupling. Fig. 14—Internal-external-gear-type coupling. Fig. 15—Roller-chain coupling.

half they are locked into place by a spring-retaining ring. The laminated members in the pins make the coupling flexible in all directions and also help prevent transmission of shock loads.

An all-steel construction is shown in Fig. 9. It consists of two flanged steel hubs, a steel-spring cylindrical grid to form the flexible members and a steel shell. The spring fits into slots in the periphery of the hubs. The slots widen inwardly to form an arc, bearing a definite relation to the thickness of the spring. When bent around the arc of the grooves, the stresses in the springs are practically constant throughout the elastic range of the coupling. The coupling is packed with grease and inclosed in a steel shell that acts as a lubricant retainer and guard.

Jaw-Type Couplings

Several designs of coupling have been developed on the principle of a jaw clutch. One of these, Fig. 10, has a separate flexible member. The flanges are made of steel with three projecting jaws on each. The flexible member is a star-shaped rubber disk. On the bearing surfaces of the lugs, the slope is such that the load on the disk is in compression over a large area.

In the clutch, Fig. 11, a center floating member can slide across the face of one coupling flange and at the same time is free to slide across the face of the other flange in a direction at right angles to the first. The floating member is a square hollow casting with a hole in the center to provide clearance for the shaft ends. On the edges of the floating member are fastened replaceable non-metallic bearing strips to prevent metal-to-metal contact in the coupling and to take the wear. This member is hollow and is filled with grease, which passes to the surface of the wearing strips through channels provided with wicks.

Disk Flexible Member

Couplings in which the flexible member is a disk or ring, Fig. 13, are used extensively. Each hub is bolted to a flexible disk ring at three equidistant points. A central member between the hubs is bolted to the disks at points midway between where the hubs are connected. The flexible rings are made of laminated, fatigue-resisting steel. Various arrangements of hubs and rings are used, depending on the size of the couplings and the service to which they are applied. To take care of both parallel and angular misalignment, two flexible rings are required, connected to the coupling hubs as in the figure. In the smaller size this is done in such a way that the coupling's dimensions are comparable with those of the standard flange types.

A popular flexible coupling uses the principle of an internal and external gear, Fig. 14. On the outer periphery of each hub is a spur gear. Surrounding the hubs is a casing, in each end of which is an internal spur gear. The internal gears engage the external gears on the hubs. In couplings of this type the flexible members are placed on the hub ends exactly opposite to the usual location. In this way the coupling is made to act as two flexible couplings with an intermediate section of shafting between them, and therefore possesses a high degree of flexibility. After assembly the coupling is filled with oil.

One of the simplest flexible couplings consists of two sprockets with a section of silent chain or roller chain connecting them, Fig. 15. In the latter, clearance between the sprockets and chain side plates allows the coupling to adjust itself to all positions of misalignment within its range.

Many other designs of flexible couplings are used but those described give a general idea of the operating principles of the various types. They all will compensate for a certain amount of misalignment, but where an excessive amount must be provided for, a double-coupling combination, Fig. 12, or a special design should be used.

Double Combination

All types of couplings are not suited to operate in double-combination, because the intermediate shaft must be held so that it will not whip. Single-engagement couplings, the flexible member of which is a laminated-metal or fabric disk, have been used extensively for this service. These couplings form a rigid support for the intermediate shaft and are sufficiently flexible to take care of the angular misalignment of the two shafts, when properly installed.

Clutches

CLUTCHES, used in a wide variety of mechanical-power-transmission applications, permit connecting and disconnecting the power source and load at will, either for one-direction rotation or forward and reverse rotation. They also make difficult starting easy by permitting the power source to be accelerated before applying the load.

Clutches are applied in two ways: as cut-off couplings or power take-offs. When a clutch is connected between two sections of shafting so that one section can be started and stopped at will, while the other section is running, it is known as a cut-off coupling. In such applications the clutch acts as a coupling that can be readily connected and disconnected between the two sections of shafting.

Power Take-Offs

In power-take-off applications part of the clutch is fixed to the shaft and part built into a pulley. When the clutch is disengaged the shaft is free to rotate in the pulley which remains stationary. Engaging the clutch locks the shaft and pulley together and the latter, with the load belted to it, is driven by the former.

All clutches fall into four general classes: jaw, friction, hydraulic, and a combination of the latter two. The square-jaw design, Fig. 1, is usually made with three jaws and the spiral type, Fig. 2, with four jaws. These clutches are suitable for slow speeds only, where they can be engaged and disengaged when the shaft is stationary. If reversing torques are likely to develop, then the square-jaw type replaces the spiral-jaw for the latter will open if its direction of rotation is reversed.

Friction clutches are built in a multitude of designs and are mechanically, magnetically and automatically operated. Manually operated friction clutches have been developed in many forms, such as single-disk, multiple-disk, single-faced and double-faced disks, radially operated, axial-operated, compression-expansion, cone, coil, and others.

A friction clutch may be considered a modified form of mechanical brake. A brake connects a stationary object to a pulley on a revolving shaft to stop it; a clutch connects a machine to a source of driving power. Both depend upon friction between two or more surfaces to accomplish their purpose.

The single-disk, axially operated clutch, Fig. 3, is of the coupling type. Disk D with its double-friction surface is bolted to flange H, the hub of which is keyed to shaft S. The clutching mechanism is keyed to shaft S_1, the end of which runs in a pilot bearing G in hub H, to insure alignment between the two halves of the clutch. Engagement is obtained by shifter sleeve A, which is free to move within collar C. This collar connects to a lever by which sleeve A is moved axially to engage and disengage the clutch.

Friction disk D runs between two metal surfaces, B and B_1. B is part of hub H_1, B_1 being carried on the hub and free to move axially under control of the operating mechanism. Levers L pivot on B_1 at P, contact adjustable collar E and connect to sleeve A by links F.

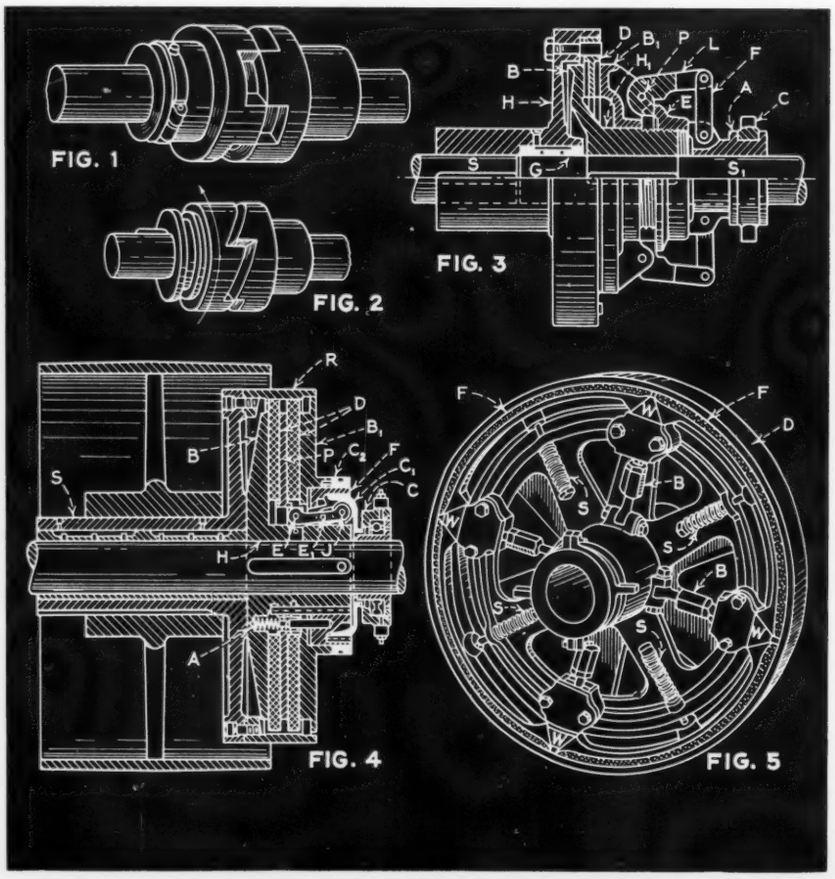
The clutch is engaged by moving shifter sleeve A to the left, which through links F forces the right-hand ends of levers L outward to turn them around pivot P. This produces a heavy reaction in levers L, pressing on collar E and friction plate B_1 to grip the friction ring between B and B_1. Shifting sleeve A to the right permits levers L to move a short distance toward the shaft to release the clutch. When friction surfaces or other parts wear, adjustment can be made by turning collar E on its threaded connection with hub H_1.

Double-Disk Clutches

Fig. 4 shows a double-disk clutch arranged for power take-off. Sleeve S is free to rotate on a lubricated bearing on the shaft and connects to external driving ring R. On the inside of R are gear teeth into which mesh teeth on the outer periphery of the friction disks D. A pressure plate P, between friction disks D, has teeth on its inner periphery that mesh into teeth in the hub. This arrangement permits the friction disks and pressure plate to take a free running position between friction plates B and B_1 when released.

Friction plate B is cast as part of

Fig. 1—Square-jaw clutch. Fig. 2—Spiral-jaw clutch. Fig. 3—Single-disk friction clutch. Fig. 4—Multiple-disk friction clutch. Fig. 5—Expanding-band clutch



hub H, keyed to the shaft. Friction plate B_1 is free to be moved axially by the operating mechanism, which is controlled by a lever attached to collar C. A toggle mechanism connects to friction plate B_1 at E_1. The clutch is shown in the engaged position.

To release the clutch, wedge-shaped collar C_1 is pulled to the right by the operating mechanism, and toggle J moves upward to free friction plate B_1 and the friction disks are released by springs A. Only one toggle and one releasing spring are shown, but to insure equal distribution of pressure on the clutch parts, three or more of each are used. Adjustment of the clutch is by collar C_2 threaded onto extension F.

Multiple-disk clutches permit greater capacity for a given outside diameter than possible with single-disk types. Some multiple-disk clutches have seven or more friction disks.

Fig. 5 pictures an expanding-band, high-capacity friction clutch with the friction band F in four sections. The band makes practically 100% contact with the inner periphery of the friction drum D. Wedges W fit between the ends of the friction shoes. These shoes, held in a released position by springs S, are applied when the clutch-operating mechanism forces wedges W out between the friction shoes F, expanding them against the friction drum. Adjustment of this clutch is made by lengthening or shortening the connections between wedges W and shifting sleeve S by turnbuckles B.

Where reversing or 2-speed drives are required from a constant-speed power source, a duplex clutch, Fig. 6, may be used. For reversing service, an open-belt drive from the power source connects to a pulley on one clutch and a crossed belt connects power to a pulley on the other clutch. For 2-speed service, the pulley from the power source to one clutch is different from that of the other drive. In reversing service, the forward speed may be made different than the reverse speed by making the pulley ratios different.

Friction Elements

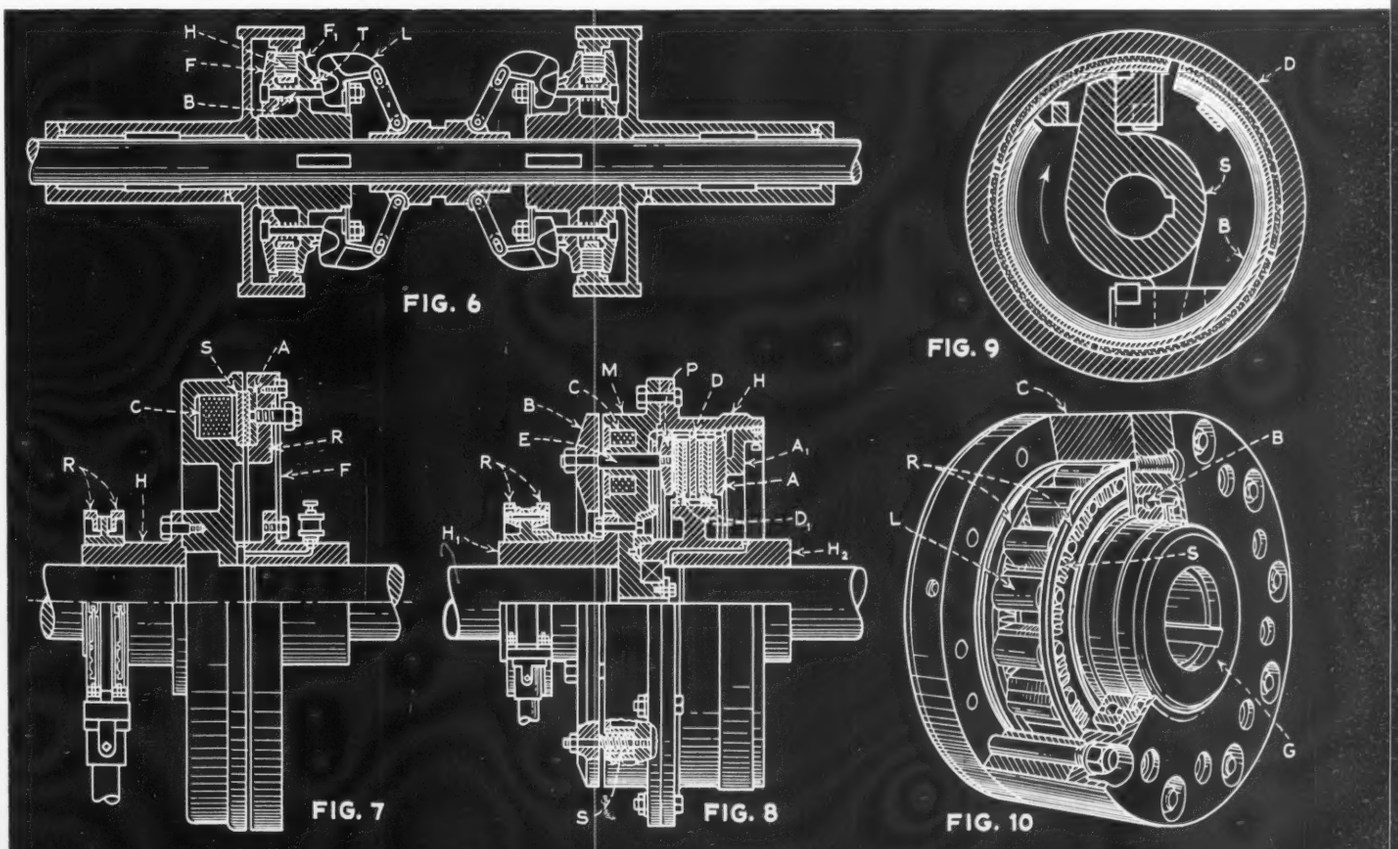
Friction elements in the clutches, Fig. 6, are hardwood block inserts H, held in an iron ring so that end-grain surfaces come in contact with the two iron friction plates F and F_1. Bolts B connect the inner end of levers L to the free friction plate F, and a toggle T forms a fulcrum between L and friction plate F_1, cast to the hub. When levers L are forced outward, as the operating sleeve is pushed toward the clutch, they draw the friction plates together to grip the wood-block friction element.

Fundamentally, a magnetic clutch is one that is closed by an electromagnet. A clutch of this type with a single disk and friction lining is shown in Fig. 7. Recessed into a steel magnet body, the magnet coil C is protected with a non-magnetic shield, S, consisting of a heavy cast-bronze ring. This part of the clutch is bolted to the driving shaft hub, H, which also carries two slip rings R that connect the magnet coil through brushes to a source of dc power.

The magnet armature is a flat steel ring R with an adjustable ring A recessed into its face. This ring is faced with friction material and forms the friction element for the clutch. A spring plate F, bolted to the driven-shaft hub, supports the armature. This plate maintains a small clearance between the two parts of the magnet when it is not energized. This clearance permits the magnet body to turn freely with the driving shaft, when the armature and driven shaft are at rest. Friction between the two parts of the magnet, when its coil is energized, produces the driving torque to accelerate the load gradually to full speed. If loads exceeds the friction, slippage occurs to relieve the overload.

Magnetic clutches are also built in multiple-disk designs, one of which is shown in Fig. 8. In this type the armature B, magnetic body M, clutch housing H, pressure ring P, drive ring D, adjustable ring A, and adjustable ring screw A_1 are all supported from the driving rub H_1. Pressure, drive and adjustable rings have gear teeth cut in their outer periphery and are driven

Fig. 6—Duplex friction clutch. Fig. 7—Single-disk magnetic clutch. Fig. 8—Multiple-disk magnetic clutch. Fig. 9—Automatic clutch makes difficult starting easy. Fig. 10—Cylindrical cams are the clutching elements in this free-wheeling clutch



by corresponding teeth in the clutch-housing inner surface, therefore revolve with it. The driven rings D_1 have a friction lining on each face and gear teeth on their inner periphery that engage teeth on the driven rub H_2.

Armature *B* and pressure ring *P* are connected by push rods *E* so that when coil *C* is energized, the pressure, driving and driven rings are forced by the armature against adjustable ring *A*. Torque due to friction between these rings accelerates the load and brings it up to speed. When the clutch is deenergized, springs *S* recessed between armature and magnet body return the armature and pressure rings to released position. Amount of running clearance and movement of the armature can be varied by the adjustable ring, which is threaded into the magnet body.

To permit using simple motors and control on loads that impose severe starting conditions, several types of automatic clutch or clutch couplings have been developed. One of these, Fig. 9, is known as a slip-ring starter. It has three elements: spider *S*, two friction bands *B* and drum *D*. The spider is keyed to the motor shaft and the drum is connected to the driven machine. Band *B* is in two parts; one end of each is connected to an arm on the spider, by which it is pulled, the rear or trailing ends of the bands being free.

As the motor speeds up, centrifugal force causes the bands to expand and exert a frictional drag on the drum. Torque transmitted depends upon motor speed, diameter of drum and weight of bands. These starters are usually made for one direction of rotation, but can be built reversible if desired. They are made in coupling types and in designs with sprockets for chain drives, pulleys and V-grooved sheaves for flat belts and multiple V-belt drives.

Free-Wheeling Clutches

Free - wheeling or over - running clutches have come into general use on dual drives from two power sources, 2-speed drives and similar applications. With these devices, as long as the power unit drives the load, the clutch remains engaged. If the driver tends to run slower than the load, or the load increases its speed above that of the power unit, the clutch immediately releases.

The free-wheeling clutch, Fig. 10, consists of three major elements: a driver, a driven, and locking or clutching members. An inner gear member *G* or the outer cylindrical element *C* may do the driving, but it is preferable to have the outer member running during free-wheeling. Locking or clutching members are cylindrical cams *L* with surfaces shaped to produce a rolling and wedging action between the driving and driven members.

During free-wheeling, the cams are always lightly in contact with the outer drum. If the driving member tends to run faster than the driven member, friction on the cams rotates them slightly and they wedge between the two members, locking them together. If the driven member tends to run faster than the driving, as, for example, when stopping, the clutch releases the load from the driver.

For some drives, such as conveyors, stokers and others, where there is danger of the load jamming, clutches can be used for overload protection only. With these designs, when the load exceeds a safe value, the clutch trips and disconnects the motor from the load. Clutches are built in designs and used in applications other than those mentioned, but this is a general picture of their construction and use.

Belt Drives

BELTS for power transmission and materials conveying are made of many materials, such as leather of several tannages, cotton fabrics of various weaves and constructions, hair fabrics, rubber and fabric, balata and fabric, synthetic rubber and fabric, hemp rope, thin flat steel, wire fabric, and combinations of all these materials fabricated in flat, V-section, round, etc.

Leather Belts

Of all the materials used for belting, leather was one of the first and still holds a prominent position. Best-quality leather belting is made from the hides of 3- to 4-year old steers, from the rear back and sides of the hide, Fig. 1. Here the fibres are compactly knit, together; outside these areas the fibres are longer and more loose, and have more stretch.

The section of a hide used for belting is called a bend. This is usually cut into three equal widths; the center one includes the line along the backbone. From these sections strips are cut to give the desired belt width. As leather coming from a hide is not of uniform thickness, the strips must be selected for uniformity so that a belt made from them will run smoothly on the pulleys.

The matched strips are cemented together to obtain desired length. A belt made of a single thickness of leather is known as a single-ply belt. For heavier loads, two single plies are cemented together to make a double-ply belt. Very large heavy belts are made 3-ply. Belt thickness varies with leather thickness and number of plies, and with the manufacturer, but the range of thickness for single-ply is generally from $\frac{1}{8}$ to $\frac{7}{32}$ in.; double-ply, $\frac{1}{4}$ to $\frac{3}{8}$ in.; and triple-ply, $\frac{7}{16}$ to $\frac{9}{16}$ in.

Before assembling the strips of belt stock into a belt, their ends are beveled as in Fig. 2, given a coating of cement and then pressed together as in Fig. 3. For double-ply belts, two single plies are cemented together, Fig. 4. When a waterproof cement is used the belt is known as a waterproof belt. In some cases the leather is also given a waterproof treatment, even though it is normally highly resistant to water.

All leather belts are operated with the hair or grain side next to the pulley. This side is smoother and has a higher coefficient of friction than the flesh side. At one time it was believed that belts trapped air between them and the pulleys, which prevented making proper contact between the two. To overcome this supposed difficulty perforated leather belts were made. Some double-ply belts are now made with the inner ply perforated on the theory that as the belt runs onto the pulley a vacuum is formed in the perforations to increase adhesion of the belt to the pulley. A widely used leather belt is made with a ribbed surface, Fig. 5, the

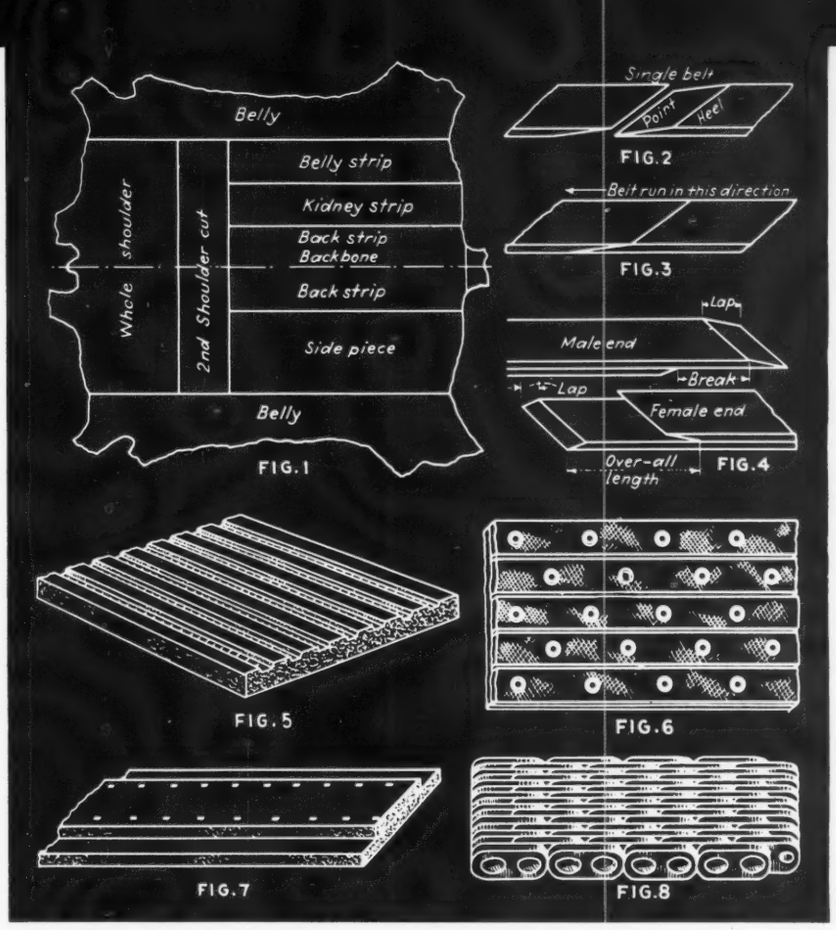


Fig. 1—Best belt leather comes from the rear-back of the hide. Figs. 2 and 3—Single-ply leather belt. Fig. 4—Double-ply leather belt. Fig. 5—Section of leather belt grooved on its inner surface to increase its coefficient of friction. Fig. 6—Combination oak- and chrome-leather belt. Fig. 7—Two-ply leather belt. Fig. 8—Leather-link belt

idea being that a ribbed surface grips the pulley better than a smooth one.

To combine the advantages of two different tanning processes, belts are made with an outer ply of oak-tanned leather and an inner ply of chrome-tanned leather. In some designs the chrome leather is cemented to the oak. The design, Fig. 6, has strips of soft, spongy chrome leather attached to oak leather with tubular rivets.

Cone-Pulley Belts

For operation on cone pulleys, the 2-ply belt, Fig. 7, is constructed with a wider outer ply of heavy oak-tanned leather and narrow inner ply of high-friction special tannage. The plies are cemented together and are also held with wire fasteners, countersunk so that they cannot contact the pulleys.

In addition to these, special flat belts are made for high speeds on small pulleys, for operation on shifter drives and step cone pulleys, flour-mill sifters, stripper service on cards in textile mills, spindle and winder drives.

Several designs of leather-link belts are available, one of which is shown in Fig. 8. Some designs have links made of single-thickness leather, others have links of 2-ply leather. In the latter the flesh sides of the two thicknesses of leather are cemented together to give a solid link with the grain sides on the outside. The bored links are assembled with steel connecting pins into belts, which are from 0.5 to 1 in. thick, and are made from 1 to 24 in. wide, depending upon the power and other requirements. They are used for heavy slow-speed drives where the belt is likely to be subjected to abuse and with a belt tightener for a clutch drive.

Leather belts having a V-cross-section to run in a V-grooved sheave are built in three types. Solid V-constructions are obtained by cementing together a sufficient number of plies to give desired thickness. To obtain a more flexible construction the bottom half is made in sections and riveted to a solid top ply. A third design is made up of links beveled to form a vee, a very flexible type for small sheaves. All of these may be considered special for low-power, short-center drives.

Solid round leather belts are made in sizes from $\frac{1}{8}$ to $\frac{1}{2}$ in. diameter. Built-up designs range from $\frac{3}{8}$ to 1.5 in. diameter. These belts are made of two or more plies cemented and cable-screwed together to prevent ply separation. Folded twist-round belts are made from flat strips of leather, folded and twisted to correct size. These have greater flexibility than the solid round and are available in diameters of $\frac{1}{8}$ to 1 in. For difficult drives requiring a certain amount of slip between belt and sheave, round belts are made of leather tanned with the hair on. These are made in small sizes only $\frac{1}{3}$ to $\frac{3}{8}$ in. in diameter. Round leather belts are used on light machinery in the textile, shoe, and similar industries.

Rubber Belts

Rubber belts are made in several different shapes and constructions using rubber and synthetic-rubber compounds. These give varying degrees of strength, stretch, pulley grip and smoothness; also protection against abrasion, oil, moisture and corrosive fumes. Cotton and rubber, or synthetic-rubber compounds are the materials used in practically all power-transmission rubber belting.

Rubber belting comprises layers (plies) of cotton duck impregnated "frictioned" with a slow-aging rubber compound. Cotton ducks of 24, 28, 32, 36, 42 and 48 oz weight are used. These values represent the weight of a piece of dry duck 36x42 in. in area; 32-oz ducks are most commonly used in rubber power-transmission belts.

The duck is first frictioned with slow-aging rubber compound, which is forced into the duck by heavy pressure between calender rolls. Belts are made by folding the duck to give the desired width and number of plies, then vulcanized in a press. Many rubber belts are made with raw edges, Fig. 9. Others are of the folded construction, Fig. 10. Raw-edge belts are generally used unless conditions are unfavorable for them. Folded-edge belts are designed for general use on drives where excessive edge wear results from belt shifters, guides, and pulley flanges, or where the drive is exposed to corrosive fumes or the weather. Folded-edge belts usually have a cover seam on the outside.

Rubber Compound

The rubber compound in the duck serves two purposes. It seals the duck against moisture and fumes and binds the plies together into a homogeneous structure difficult to separate. The force, measured in pounds per inch width of belt, required to separate one ply from another is known as the "friction" of the belt. A rubber belt is said to have a 24-lb friction when a pull of 24 lb is required to separate a strip of one ply 1 in. wide from the belt at the rate of 1 in. per min.

Most general-purpose rubber belts are friction-surfaced only, that is, the

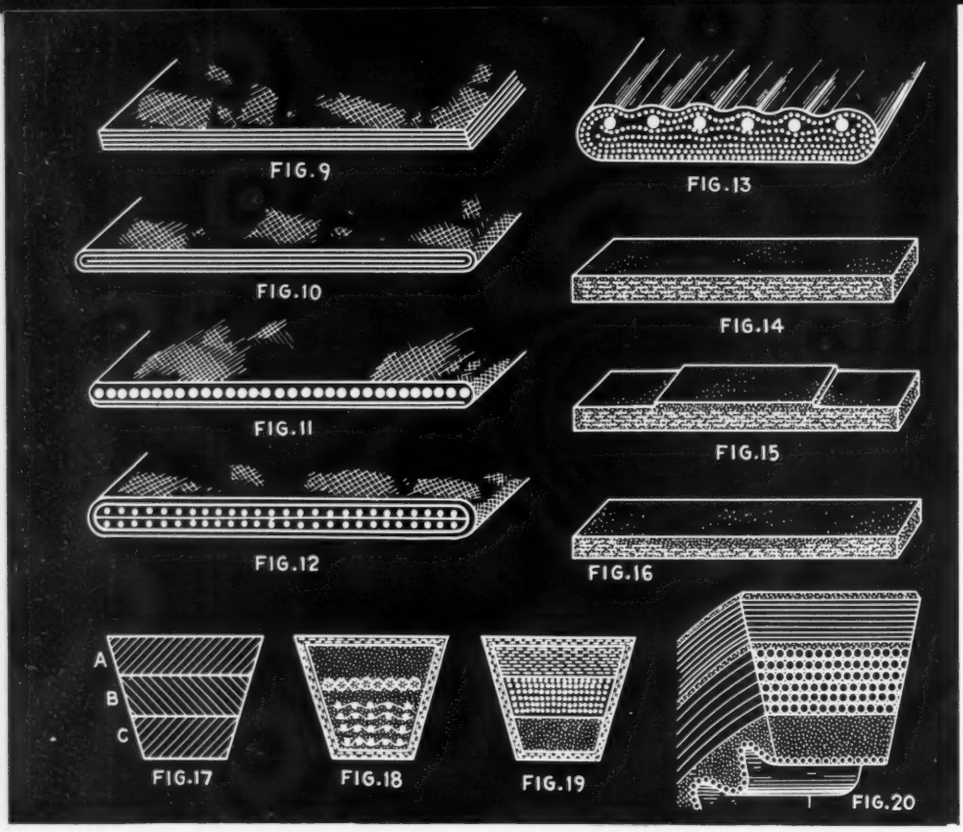


Fig. 9—Raw-edged frictioned-surface rubber belt. Fig. 10—Frictioned-surface folded-edge rubber belt. Figs. 11 to 13—Different constructions of cord rubber belts. Figs. 14 to 16—Three constructions of rubber conveyor belts. Fig. 17—*A*, tension zone; *B*, neutral zone; and *C*, compression zone in a V-belt. Figs 18 to 20—Three constructions of V-belts

only rubber in the belt is that put into the duct before the plies are put together. For special purposes, such as operation where steam, acid fumes or abrasive dusts are present, belts are made with rubber coverings to protect the fabric. Other constructions include those having one or two layers of rubberized cord, Figs. 11 and 12, laid parallel along the center of the belt, to take the load. This produces an endless belt without a splice. The cords are imbedded in rubber and encased in a frictioned-fabric envelope.

Fig. 13 shows another design of cord belt built around two sets of cords. The large cords are in the top side of the belt and are intended to hold the load-pulling smaller cord section against the pulley. Both layers of cords are imbedded in a rubber compound. An outer heavy-fabric jacket encloses and protects the cords from wear and atmospheric conditions.

Conveyor Belts

Conveyor belts must do double duty: transmit power and convey material. These are built in many designs to meet the various purposes for which they are used. For handling abrasive heavy materials like coal and stone, rubber belts are built in three general classes. One of these, Fig. 14, consists of uniform duck and rubber across its full width. An extra heavy layer of rubber on the top surface and around the edges resists wear of the material handled.

Where severe abrasion must be resisted, the rubber cover is made extra thick along the center of the belt, Fig. 15. To increase rubber thickness at the center of the belt and keep a uniform thickness across its width a stepped-ply construction, Fig. 16, is used. This gives extra rubber where wear is most severe and permits the belt to trough readily on the rolls.

V-Belt Drives

V-belts are made of rubber or synthetic-rubber and cotton constructions, although varying in design with the manufacturer. They are trapezoidal in cross section, Fig. 17 and run in grooved sheaves. When a belt is bent around a pulley its cross-section may be considered as made up of three zones: an outside one *A* in tension, a center zone *B* that is neutral, and an inner zone *C* in compression. In all V-belts the neutral zone is the power-transmitting section.

In the V-belt, Fig. 18, the load is carried entirely by a layer of heavy, high-tensile endless cord, impregnated with liquid rubber and placed in the neutral zone of the belt. The tension zone above the cord is made of a rubber stock, while the compression zone is of fabric-cord and rubber. A fabric envelope impregnated with rubber compound takes the belt wear.

Fig. 19 shows a belt with its load-carrying sections made of several layers of pre-stretched cord impregnated with rubber compound. Above this, a tension section of layers of impregnated bias-cut fabric gives the belt transverse stiffness against buckling between the sides of the sheaves. Below the cord a section composed of rubber serves as the compression member: The entire belt is enclosed in a fabric envelope. In the belt, Fig. 20, the tension section is made of rubber-impregnated bias-cut fabric, the load-carrying section of cord fabric and a compression section of rubber, corrugated to help take the effects of compression. This belt does not have a fabric envelope.

A V-belt drive may comprise from 1 to 30 or more strands in multiple. Originally, these belts operated on two V-grooves sheaves only. They are now sometimes used to drive a large flat pulley with very little crown from a small V-grooved sheave. These are known as V-flat drives. Multiple V-belts generally operate on straight open applications, but have been developed for most services where flat belts can be used. Round rubber belts in a wide variety of constructions and sizes are also available.

Other Belts

Flat fabric belts are also impregnated with balata, a vegetable gum somewhat similar to guttapercha, obtained from the sap of trees growing in South America.

Canvas belting is made in several forms. Several types of hair belts, generally known as camel-hair, are also available. These are solid woven from long-fibre hair of Chinese and Siberian camels and long fibre cotton yarns. Hair belts are also made of various mixtures of hair and woolen yarns. These belts are used extensively on oil-field drives and have qualities that make them well suited for wet conditions, for temperatures up to 300 F and in contact with fumes of corrosive acids.

Metal belts are used in many forms, particularly for high temperatures. Flat steel belts are from about 0.02 in. to 0.05 in. thick and from 8 to 90 in. wide. Metal belts are also made in a wide variety of wire meshes, many of them similar to those used in wire fences. The wire may be of plain, galvanized, tinned, stainless or alloy steels, Monel metal, brass, bronze or aluminum to suit conditions of temperature, corrosion resistance, etc.

Rope Drives

ALTHOUGH ROPE DRIVES were one of the first forms of mechanical power-transmission equipment devised (the ancient Egyptians used them on their chain-of-pots pumps), the drives we know today date back less than 100 years when hemp rope was first used on grooved sheaves. As the art progressed, many forms were developed for very large as well as for comparatively small power applications, many of which gradually passed out of use with the advent of individual and small group drives from electric motors.

As an example of what some of these systems involved, four sheaves for rope drives in New York City weighed 104 tons each, were 32 ft in diameter, and were grooved for 34 2-in. ropes. A sheave installed on the main drive in a cotton mill in India weighed 140 tons, was 30 ft in diameter with a 15-ft face grooved for 60 2-in. ropes to transmit 4000 hp. Some of the drives were very elaborate, with groups of ropes running from the main sheave to sheaves on line shafts on each of five or six floors to power a whole plant.

Ropes made of a wide variety of materials have been used, including iron or steel ropes for very long drives. These usually comprise a single rope and have been installed to transmit power a distance of several thousand feet. Non-metallic materials are most commonly used on rope drives, such as rawhide, round leather formed by twisting narrow strips, solid round leather made of several thicknesses cemented and wired together in sizes up to 2.5-in. diameter. Others include leather rope having either a square or a triangular cross section, running on V-grooved sheaves, wire rope with leather washers closely threaded on it, wire rope covered with marlin or other non-metallic material; flax, hemp, cotton and manila rope.

Of these materials cotton and manila are the most popular. Cotton ropes were given preference in England and manila in the United States. The first-named has the advantage of being more flexible, can be used on smaller sheaves and has less internal wear than manila rope. However, it has only about 65% of the strength of a manila rope of equal diameter.

High-grade manila transmission rope is made in sizes of ½- to 2-in. diameter and usually of 4-strand construction with a center core of soft absorbent hemp. This center core forms a backing for the strands and holds the special lubricant with which the rope is treated.

English System

Rope drives have been developed in two forms: The English or multiple-rope system and the American or continuous-rope system. The English system uses separate parallel ropes spliced endless, Fig. 1. In this system horizontal or inclined drives are preferred with the slack side of the ropes on top. The slack then tends to increase the arc of contact of the ropes with the sheaves.

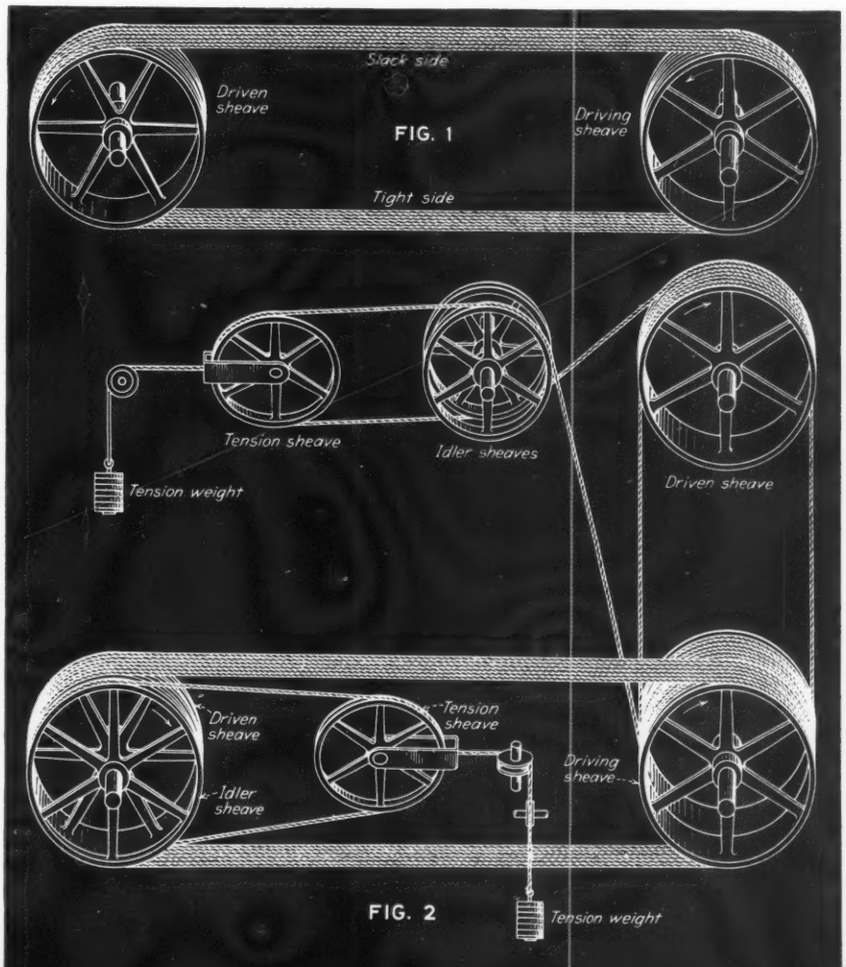
The English system is not suited to vertical applications, because as the ropes stretch they tend to drop away from the bottom sheave and decrease the power that can be transmitted. They also have the disadvantage of not providing automatic tension adjustment, necessary when ropes stretch or contract with change in humidity. They do have the advantage, however, that if one rope breaks the drive will continue to operate.

American System

In the American or continuous system a single rope is reeved over the sheaves a sufficient number of times to transmit the power load. The ends of the rope are spliced together to form a loop around a tension sheave, Fig. 2. The tension sheave also serves to transfer the rope from one outside groove of the driving sheave to the opposite groove of the driven sheave.

The automatic tension sheave maintains uniform tension in the ropes regardless of stretch, temperature, air humidity, or load variations. Because of the automatic tension sheave this drive can operate vertically, see Fig. 2. For very large applications it is advisable to divide the drive into sections limiting the rope length to 3000 ft and the number of rope strands in each to about 10 or 12, with a tension sheave on each section.

Fig. 1—English or multiple system of rope drive. Fig. 2—American or continuous system of rope drive can run horizontally or vertically



Chain Drives

POWER-TRANSMISSION CHAIN is a comparatively newcomer in the field, being only a little over 60 years old. In this short time, however, it has been developed in many forms for power drives and materials-handling equipment. Its great strength permits transmitting large power with comparatively small cross sections and it can operate in temperatures that would quickly destroy belts and ropes.

A chain drive is simple in construction and consists of two or more toothed wheels called sprockets mounted on parallel shafts and engaged by the links of an endless chain. Center distance between two adjacent chain joints is called the chain pitch or sprocket pitch. Diameter of a circle drawn through the center of chain joints in mesh with the sprocket is the pitch diameter of the sprocket.

Detachable-Link Chain

The first chains made consisted of malleable-iron link castings, Fig. 1, which were assembled readily into continuous chains that ran on cast-iron sprockets. This chain is detachable at every link for shortening or lengthening. It was known as a detachable-link belt, being first applied to agricultural machinery and afterwards to general industrial drives. It is suitable for speeds up to approximately 400 ft per min.

Detachable link chains are also made with strip-steel links, Fig. 2. The links are formed by stamping from a single piece of steel, are heat treated, and therefore have greater strength and durability than the chain, Fig. 1. Links of this chain will not intercouple with those of Fig. 2.

Closed-End Pintle Chain

Closed-end pintle chains, Fig. 3, use malleable-iron cast links connected by steel pins or rivets, have greater strength, better protected joints and are of more sturdy construction than detachable-link chains, for given outside dimensions and weight. This type of chain is also limited to a speed of 400 fpm but can be lubricated more readily than the chain of Fig. 1 and if given proper care should have greater life under equal conditions. It costs more and is not as readily opened at the link joints for adjusting its length.

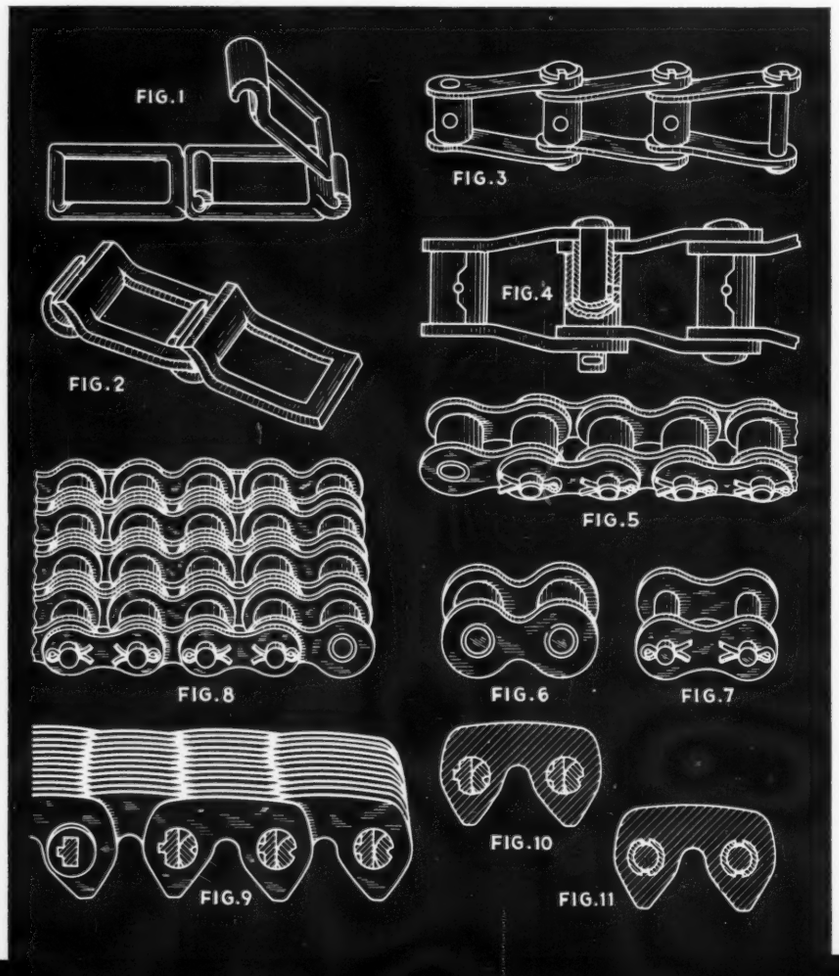
Bushed-steel-roller chains, Fig. 4, with hardened bearing surfaces and rollers, are made in a large variety of sizes and pitches. These have greater strength and durability than the chain, Fig. 3, and can be used for speeds up to 600 fpm.

All these chains run on cast-tooth sprockets and can operate satisfactorily with almost any ratio and relative position of sprockets, with slack side on either the top or bottom of the drive. However, vertical or nearly vertical drives with the large sprocket on top, cannot operate with very much slack in the chain, because it tends to drop away from the lower sprocket when the chain elongates from wear.

Finished-steel-roller chain, Fig. 5, on cut-tooth steel sprockets, is a highly developed type that can be operated at high speed and can be built to transmit large power. It consists of a roller link connected by pins and side links. A roller or inside link, Fig. 6, is an assembly of two rollers and two bushings, the ends of which are pressed into holes in the two side links. A pin or outside link consists of two pins, the ends of which fit tightly into two pin-link plates, Fig. 7.

Medium-carbon, cold-rolled or medium-carbon, hot-rolled alloy steels, heat treated, are most frequently used for side plates. Low-carbon and alloy steels suitable for case hardening are commonly used for pins, rollers and bushings. Well finished surfaces to resist wear, for accuracy and uniform dimensions, are obtained by grinding. The most important attribute of roller chains is resistance to wear between pins and bushings, a property depending upon hardness and finish of the parts, other things being equal. Roller chains have their pins held in place by

Fig. 1—Detachable-link chain with malleable-iron links. Fig. 2—Detachable link chain with formed steel links. Fig. 3—Closed-end pintle chain uses malleable-iron cast links. Fig. 4—Bushed steel-roller chain with hardened bearing surfaces. Fig. 5—Single-strand finished steel-roller chain. Fig. 6—Roller or inside link. Fig. 7—Pin or outside link. Fig. 8—Multiple-strand finished-steel roller chain. Fig. 9—Silent chain. Figs. 10 and 11—Two types of silent-chain link joints



rivets, by cotter or other types of pins.

Tooth strength for a chain sprocket is much less important than for gears. Loads are shared by several teeth and are applied below the pitch line, except when the chain is badly worn. Therefore, strength of a material is usually not a factor in selecting sprockets. Cast-iron or cast-steel sprockets are usually suitable for use on low and moderate-speed shafts.

For small sprockets, 6 in. or less in diameter, low-carbon steel is frequently used. Either drop-forged steel or cast steel is used for driving sprockets of heavy chains. Where there is a large difference between the diameters of two sprockets in a drive, it is general practice to make the large sprocket of cast iron or unhardened steel and the small sprocket of low-carbon steel case-hardened or of a high-carbon steel heat-treated. Alloy steel and case-hardened sprockets are seldom used for diameters greater than 9 or 10 in. No matter what sprockets are made from, they are machined to very close tolerances for finished steel roller chain.

When a single-strand roller chain, Fig. 5, will not transmit sufficient power, multiple-strand chains may be used, Fig. 5, will not transmit sufficient power, more multiple-strand chains may be used in parallel.

Properly selected roller-chain drives can operate at sprocket speeds up to 4000 rpm and peripheral speeds up to 4000 fpm, but usually peripheral speed is held to 1500 ft or less. High chain speed requires light short-pitch chains. Heavy long-pitch chains are suitable for slow speeds only.

A silent chain, Fig. 9, is really a flexible form of endless rack connecting two sprocket wheels. It is made up of a series of steel leaves or links and special pins. In Fig. 10, the pins forms a rocker or rolling joint to eliminate sliding friction. These pins are made of case-hardened steel and are securely held in the link holes so that they cannot move.

In Fig. 11 a case-hardened circular pin is used between two case-hardened semi-circular bushings, extending across the entire width of the chain. The bushings are fixed in position, but the pins are free to rotate so that they wear uniformly and keep round. The links are made of alloy steel punched to very accurate dimensions, hardened to resist wear. The resulting toughness from the hardening process gives high tensile strength and resistance to fatigue and breakage.

Pinion sprockets are cut from case-hardened, open-hearth steel; nickel steel is used for the larger sprockets. Sprockets can be made split where necessary or where such construction will facilitate installation. Use of this type will frequently save the expense of taking down shafting and hangers. Where because of pulsating power load, a whipping action may be produced in the chain, equalizing spring sprockets may be used to smooth out the uneven strain. These are often desirable on compressor or engine drives, where the flywheel effect is not sufficient to prevent the chain whipping. In one design, springs are placed in the sprocket rim where they operate to the best advantage.

Where a protective device is needed to guard against sudden extreme overloads or where machines may stall, shearing-pin sprockets may be used. An overload sufficient to cause damage will shear the pins and the rim is then free to turn on the hub.

Silent-chain drives normally operate at speed of 1500 fpm or less, but, when properly applied, can run up to 4000 fpm. They are built in capacities from fractional to 5000 hp.

Modern chain drives, specially those operating at the higher speeds, are inclosed in a casing to protect them from dust, dirt and injurious fumes, and to insure proper lubrication. Lubrication may be applied to the chain from a drip oiler, or by a ring, disk or pump picking up oil from a pool and distributing it onto the chain. Slow-speed chains may be lubricated by permitting a low part of the chain to run into an oil bath.

Variable-Speed Transmissions

TODAY'S INDUSTRIAL PRODUCTION methods often require wide ranges of speed adjustment or close speed control. Frequently, a simple constant-speed motor with a variable-speed transmission is the most economical way of meeting these requirements.

Stepped pulleys with belt-shifting devices and gear-changing equipment have been and are being used to obtain changes in speed. Such devices vary the speed in steps that are too large for close speed regulation. There are, however, many places where these devices are used successfully, either with constant- or adjustable-speed motors. Several types of equipment are available to adjust speed in infinitely small steps and are widely used on industrial power drives. These may be divided into mechanical and hydraulic types.

Variable-speed transmissions using some form of belt on or between cones are among the most popular types. One of these, Fig. 1, consists of two cone pulleys of equal size, set parallel, with the cones pointing in opposite directions. The pulleys are connected by a flat belt. Under the belt, the surface of each cone is built up from conical to cylindrical form by a cone-pulley transformer *T*. The transformer consists of a series of tapered leather strips riveted onto an endless belt. One of the cone-pulley shafts connects to the source of power and the other to the driven machine. With the power-input cone operating at constant speed, the output-cone speed changes as the belt is shifted along the pulleys.

In the variable-speed transmission, Fig. 2, two pairs of conical-faced disks, splined and mounted on parallel shafts and connected by a V-shaped belt, form the adjustable-speed element. The V-shaped belt fits the throat between each pair of disks and is made by clamping a heavy cable-cord endless rubber belt between hardwood blocks. These blocks are beveled and ground at their ends to fit the V-groove between each pair of disks. Both rows of blocks have their ends tipped with a special tannage leather to give high coefficient of friction between belt and disks and to distribute the load equally between the blocks.

Diameter of the belt tread on the V-shaped pulleys is adjusted by two levers connected to the disks in such a way that, in Fig. 2, for example, when disks *A* are separated, disks *B* are brought closer together. This operation

allows the belt to ride farther down between disks *A* and causes it to ride farther up on *B*. The effect is to decrease the diameter upon which the belt runs on *A* and increase it on *B*. Therefore, if *A* runs at constant speed the speed of *B* will decrease. Reversing the operation brings disks *A* together and separates *B*, thereby increasing the speed of the latter.

The variable-speed transmission Fig. 3, operates on the same principle as Fig. 2, using a special type of metal V-chain. Radial teeth are cut in the conical faces of the disks, Fig. 3. In the chain, what may be called teeth are formed in packs of hardened-steel laminations, extending through the links at right angles to them and projecting about $\frac{1}{8}$ in. on each side of the chain. The teeth are so staggered on each pair of disks that the laminations move back and forth into the teeth as the chain comes into contact with the wheels, as shown in Fig. 3. All elements of this unit are built into an oil-tight housing and automatically splash lubricated. Another design of this type of transmission uses a special roller chain between smooth-faced disks.

Multiple V-Belts

Variable-speed transmissions also use multiple V-belts running on multiple grooved sheaves that can have their pitch diameter adjusted. The V-belts, sheaves and adjustment mechanism are assembled into a case to form a complete unit onto which the driving motor can be mounted.

Variable-speed transmissions are also built on the principle of a variable-ratio planetary gear, but use conical-shaped rolls instead of gears. Figs. 4 and 5 illustrate the principle of one of these types. The outer race for the conical rolls is held stationary in a casing but can be adjusted endwise to change the race diameter on which the rolls run. The inner races connect to the input shaft and are held against the rollers by spiral springs. Only one double conical roller is shown, but in a complete unit there are three, supported 120 deg apart in a cage, and connected to the output shaft.

In Fig. 4, the inner race contacts the smallest diameter of the roller and the outer race the largest diameter. Now, if the inner race is revolved it will drive the roller at a maximum speed around the outer race and output speed will be maximum. The inner race, Fig. 5, contacts the rollers at their maximum diameter and the outer face their minimum diameter. Consequently, the roller will be driven at a minimum speed around the outer race and the output speed will be at a minimum. Therefore, simple adjustment of the position of the races varies the output speed of the unit over a wide range.

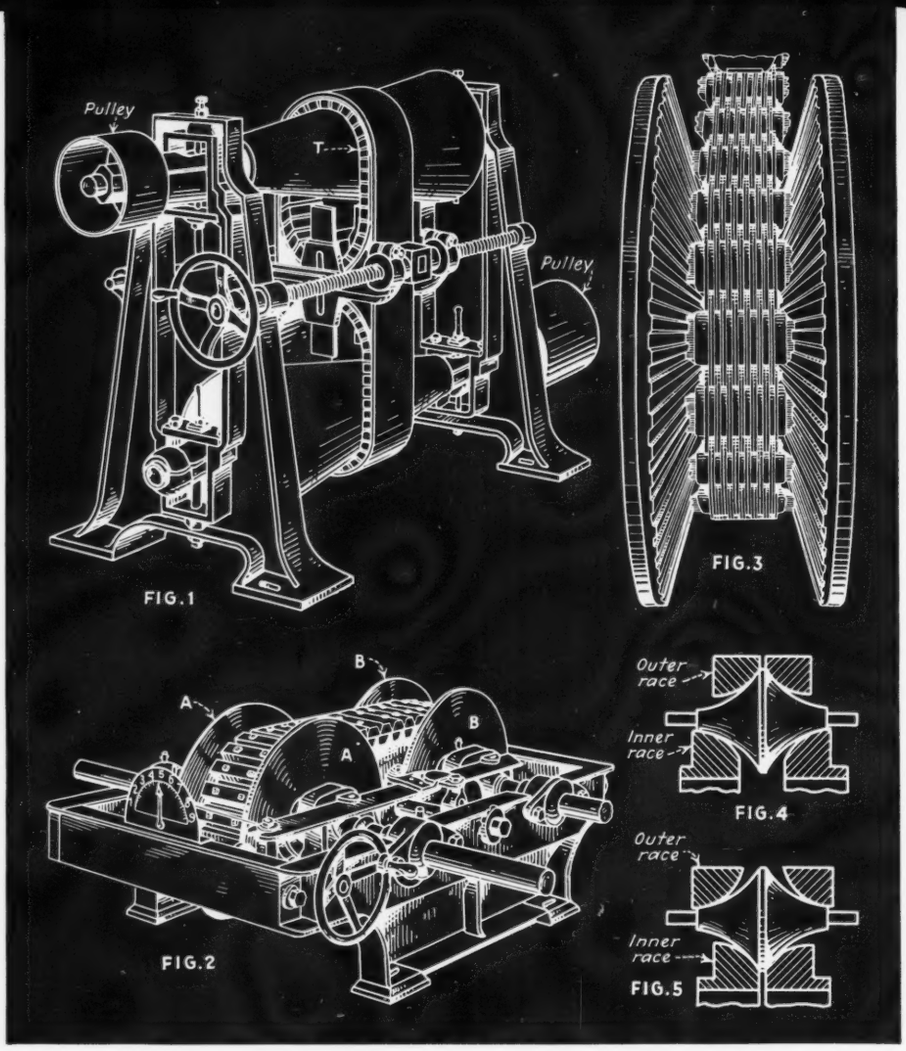


Fig. 1—This variable-speed unit consists of two opposed cone pulleys connected by a flat belt. Fig. 2—Two pairs of conical-faced disks connected by a special V-belt provide adjustable speed in this unit. Fig. 3—All-metal variable-speed unit operates on the same principle shown in Fig. 2. Figs. 4 and 5—Principle of variable-speed unit using variable-ratio planetary rollers between adjustable inner and outer races

Hydraulic Types

Hydraulic-type variable-speed transmissions fall into two general classes: Those that give constant adjusted output speed irrespective of load and those in which adjusted speed varies with load changes. Fig. 6 shows a cross-section of a horizontal-piston design of the first type. It consists of a piston pump and motor in a casing and uses oil for the transmission fluid. Six pistons in both pump and motor arranged in a circle connect to socket rings *R* and R^1. On the motor the socket ring is fixed in the position shown; in the pump the ring is mounted on a tilting plate and can be moved through the angle between *X* and *Y*. In the pump and motor the pistons and their cylinder barrels *B* are free to rotate. The pump discharges into valve block *V* from where the oil goes into the motor cylinder.

In Fig. 6 the tilting plate and socket ring of the pump are shown in neutral position, that is, they are perpendicular to the input shaft. If the input shaft *S* is turned, socket ring *R* and cylinder barrel *B* will turn with it but the pistons will not move in the cylinders of either pump or motor.

Shifting the socket ring by control *C* to position *XX* will pull the top pistons out and push the bottom pistons into their cylinders, as indicated by the position of the motor pistons. With the socket ring tilted to position *XX*, when the socket ring and cylinder barrel revolve one-half revolution, the pistons that were at the bottom will be on top and those on top will be on the bottom. In this change of position, the top pistons were pushed into their cylinders and the bottom pistons pulled out. That is, by rotating the socket plate when in a tilted position, the pistons are made to move back and forth in their cylinders and deliver oil to the motor to drive it.

Motor speed depends upon position

of the pump's socket ring, being zero when the ring is vertical and equal to output speed when pump socket ring is tilted to the same angle as that of the motor. Intermediate positions of the pump ring give intermediate speed. Shifting the pump socket ring to position *YY* will reverse rotation of the motor. Thus, by shifting the position of socket ring *R* any speed may be obtained from full speed in one direction to full speed in the opposite direction.

Figs. 7 and 8 show cross sections through a radial piston pump for a hydraulic variable-speed transmission. Cylindrical valve *V* is fixed and cylinder body *B* with its pistons *P* are supported in casing *C* so that they can be rotated about the cylinder valve acting as a fixed shaft. Pistons *P* and their casing are mounted so that they can be moved horizontally to place their center of rotation to the left or right of valve *V*.

When the pistons are placed so that their center of rotation coincides with the axis of valve *V*, the pistons will not move in their cylinders when the pump is rotated. If the floating ring in which the pistons are carried is moved off center with the cylinder body and the valve, Fig. 7, the pump will discharge when rotated.

In Fig. 7 (assume clockwise rotation), the pistons above valve *V* will move into the cylinders and fluid will be discharged through the two top ports of the valve. Pistons below valve *V* will be moved out of the cylinders and fluid will flow into the pump. Moving the floating ring with its pistons so that their center of rotation is to the right of valve *V*, Fig. 8, reverses pump into the bottom valve ports and fluid flows from the top ports into the cylinders.

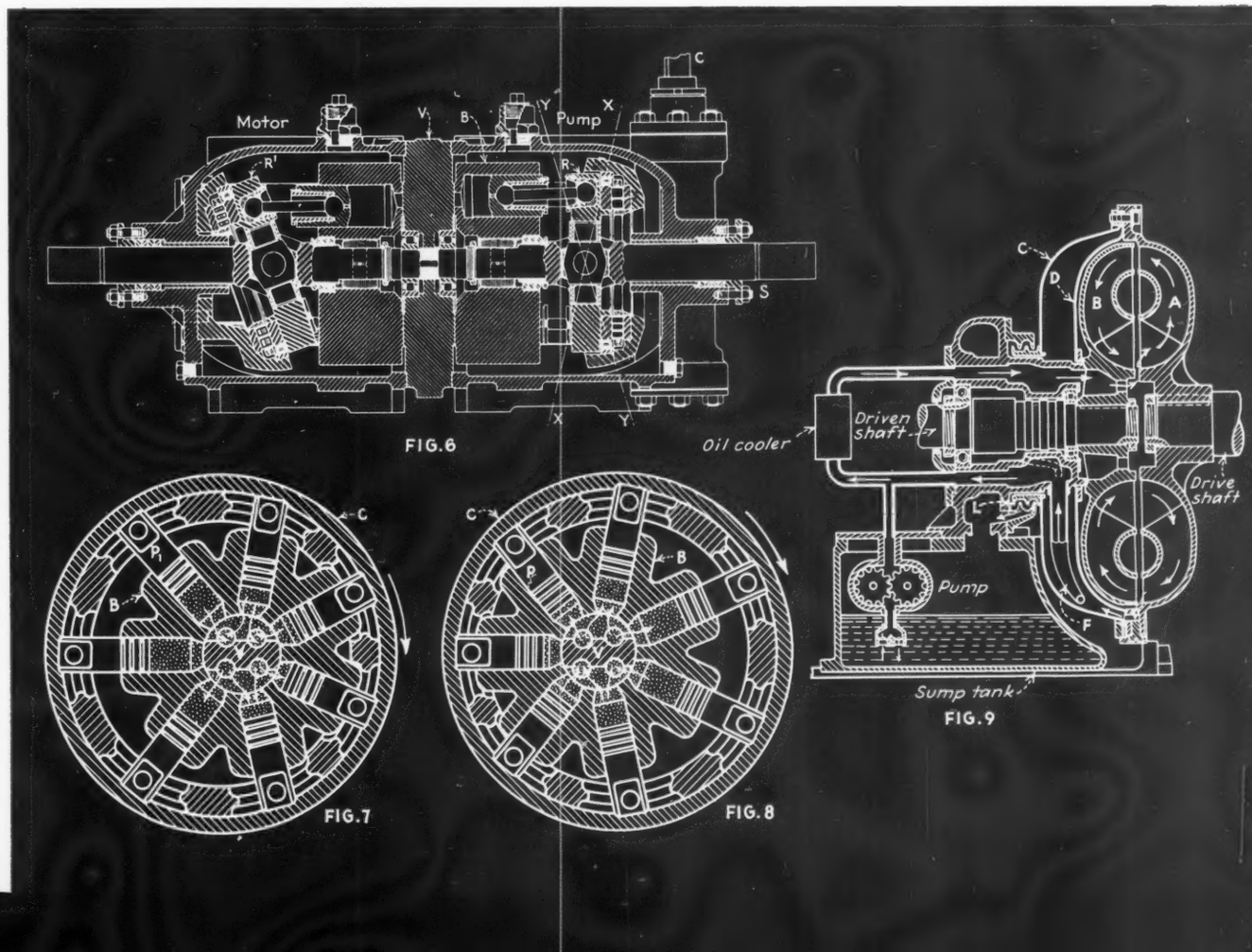
The ports in pump valve *V* connect to ports on a similar valve in the motor which has its cylinder set off center permanently with the valve. As the pump discharges into the motor its cylinders rotate at a speed and direction depending upon how much the pump cylinder is offset with relation to the valve. Speed of the motor will be zero when the pump cylinders are central around valve *V* and at a maximum when the cylinders are given maximum offset. Moving the pump cylinders to one side of their valve causes the motor to rotate in one direction and to the other side causes the motor to reverse its rotation.

A third type of hydraulic variable-speed transmission is known as a hydraulic coupling, Fig. 9. This unit consists of what is equivalent to a pump *A* keyed to the driving shaft and the equivalent of a water wheel *B* keyed to the driven shaft. Inner and outer casing *C* and *D* attached to the outer periphery of the pump and are rotated with it.

Assuming the working circuit of the coupling to be filled with oil and the pump rotating, centrifugal force will cause oil to flow from the pump buckets into those of the runner, as indicated, and cause it to rotate. A certain amount of oil is permitted to leak from the bottom of the impeller into the space between the casings. From here the oil is picked up by scoop tube *F* and after passing through a cooler is returned to the working circuit of the coupling, as indicated by the arrows.

A small motor-driven rotary pump, connected into the coupling circuit, supplies oil to or removes it from the coupling to change speed of the driven shaft. Oil removed from the coupling is stored in the sump tank. When the coupling is filled with oil its output speed is about 98% of input speed. When driving a fan or centrifugal pump and with the coupling empty, the output speed is about 20% of input speed. Any speed between these two values is obtainable by filling the coupling to where it gives desired speed. When the coupling is shut down with more than enough oil to fill the lower half of the working circuit and casing, surplus oil flows back into the sump tank through labyrinth *L*. This type of drive is best suited to loads such as fans and centrifugal pumps, where power drops rapidly with speed.

Fig. 6—Horizontal-piston, hydraulic variable-speed unit. Figs. 7 and 8—Radial-piston, hydraulic, variable-speed transmission. Fig. 9—Hydraulic-coupling variable-speed unit consists of a pump on the driving shaft and a waterwheel on the driven shaft



Bearings and Hangers

IN SPITE OF ALL we hear about direct and individual drives, group drives from line shafts still have an important share in power applications. Modern group drive differs from the old in many respects. It is intended for comparatively small groups of small and medium-powered machines. Shafting is comparatively short, light, high-speed, and operates in anti-friction bearings, supported on a system of steel channels attached to the building, Fig. 1. The channel-irons not only provide good support for the shaft hangers, but they can be easily moved along the steel work to locate the bearings at load points, insuring minimum shaft distortion. The bearings, being adjustable both vertically and horizontally in their supports, permit easy alignment of the shafting and insure high operating efficiency.

Bearing Hangers

Shafting bearing hangers are made in a wide variety of forms to meet practically every need of mounting on ceiling, floor or wall. Hangers of the type shown in Fig. 2 support the bearing at two points and therefore provide solely for vertical adjustment of the bearings. Horizontal adjustment of the bearing must be obtained by moving the hanger horizontally, the holding bolt holes being slotted for that purpose. The hanger, Fig. 3, supports the bearing at four points and provides for both vertical and horizontal alignment of the bearing and shaft by adjusting screws.

The hanger shown in Fig. 4 is for anti-friction bearings and supports them at two points. These bearing supports have large vertical adjustment with small horizontal adjustment for shaft alignment. A special shaft hanger, Fig. 5, supports the ends of two right-angle shafts connected by bevel gears. The pillow-block bearings are adjusted vertically by wedges *W* and adjusting screws *S*. Horizontal adjustment is made by screws S_1.

Lineshafts run in either sleeve or anti-friction bearings. Lubrication of the older types of lineshaft sleeve bearings was very much of a hit-and-miss proposition. Modern sleeve bearings are generally ring oiled, as in Fig. 6, but wick oiling is also used. Ring oiling gives a continuous flow of oil to the bearings to maintain an oil film for good operation. Top and bottom halves of the bearing are of cast iron lined with babbitt metal that supports the shaft. A pivot in the bottom housing supports the bearings to make it self-aligning. Shaft speed in these bearings is usually limited to 150 to 300 rpm, depending on conditions.

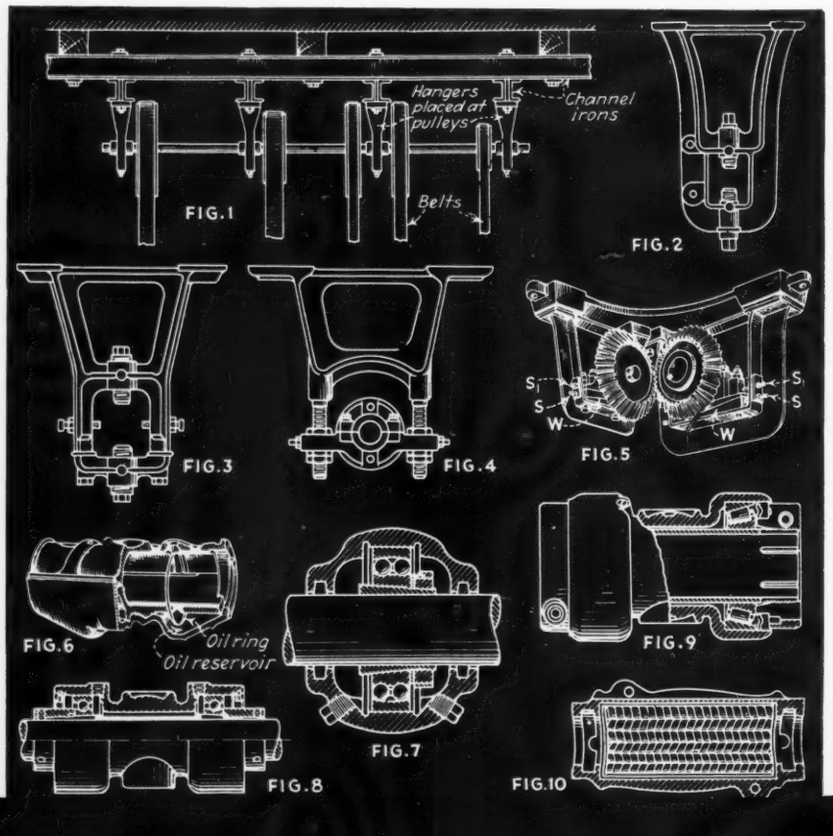
Anti-Friction Bearings

Lineshaft anti-friction bearings are made in several designs supported in many types of housings. One of the most simple is the self-aligning ball type, Fig. 7. This bearing has an inner race fixed on its shaft so that all wear occurs on the races and balls and not on the shaft. It is mounted to take care of a reasonable amount of shaft misalignment caused by loads between hangers or by other conditions that might distort the shaft.

Fig. 8 shows a double-ball bearing, consisting of a single row of balls in each end of a long housing, comparable to that used for sleeve bearings. It is intended to go into the same 4-point mounting as Fig. 3. Installation consists of simply sliding the completely assembled bearing with its end collars along the shaft into position in the hanger, tightening the hanger bolts to align the shaft properly and then tightening the setscrews in the two end collars to hold the ball races in place on the shaft.

A bearing somewhat similar to Fig. 8, but using tapered rollers, is shown in Fig. 9. Roller races are mounted on a sleeve fastened to the shaft. All load is carried on the hardened rollers and races, thus eliminating wear on the shaft. The bearing, Fig. 10, is similar to a sleeve bearing, with the babbitt-metal lining replaced by long rollers. The rollers are of two types: one made by forming a piece of flat steel similar to a coil spring; the other type consists of round steel bars cut to bearing length. Both types are ground accurately to dimensions. Some of these bearings use a thin steel sleeve between the shaft and rollers, while in others, the rollers run directly on the lineshaft. For these bearings the housing is split in half so that they can be easily installed on the shaft.

Fig. 1—Modern group drive with lineshaft bearing hangers supported on channel-iron structure. Fig. 2—Hanger supports bearing at two points. Fig. 3—Hanger supports bearing at four points. Fig. 4—Hanger for anti-friction bearings. Fig. 5—Combination hanger supports end of shaft at right angles, driven by bevel gears. Fig. 6—Lineshaft sleeve bearing. Figs. 7 to 10—Types of anti-friction lineshaft bearings



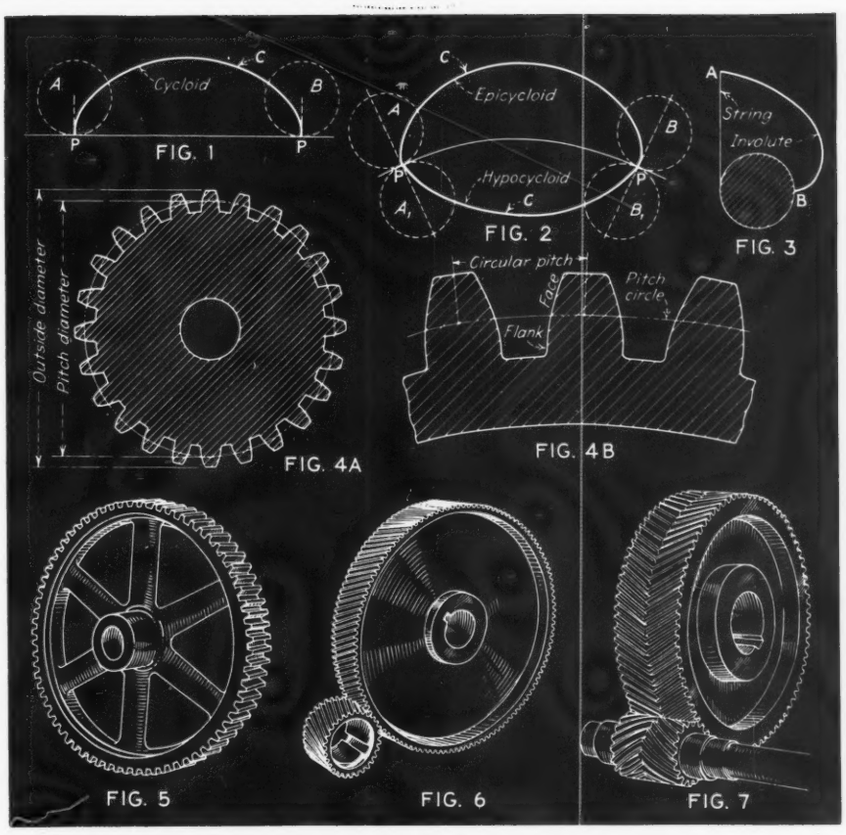


Fig. 1—Cycloid. Fig. 2—Epicycloid and hypocycloid. Fig. 3—Involute. Figs. 4*A* and 4*B* —Names of different gear parts. Fig. 5—Spur gears. Fig. 6—Helical gears. Fig. 7—Herringbone gears are a combination of two helical gears

Gear Drives

GEARS are among the oldest power-transmission devices used by man, dating back thousands of years. The early designs were very crude wooden affairs compared to modern gears built to precisions of one ten-thousandth of an inch. Modern gears are built in many forms and from materials ranging from silk to heat-treated alloy steels.

Gear teeth, to mesh properly with a rolling action, must be formed according to certain natural curves, such as cycloid, epicycloid, hypocycloid, involute and modifications of these. A cycloid is a curve generated by a point on a circle rolling along a plane. For example, in Fig. 1, if a circle in position *A* makes a complete revolution to position *B*, point *P* on the circle will follow path *C*. This curve is known as a cycloid.

If a circle is rolled along the outside of a circle, Fig. 2, the curve *C* followed by point *P* is called an epicycloid. A hypocycloid *C* is described when the small circle is rolled along the inside of larger one, Fig. 2. An involute is a curve that the end of a string will follow if wound onto a cylinder. For example, in Fig. 3, if the string is kept taut and wound onto the cylinder by swinging its end out through space the end will follow a curve *AB*, which is an involute.

Gear dimensions are expressed in a number of terms. First, outside diameter is the over-all diameter measured to the ends of the teeth. Pitch diameter is the diameter of the pitch circle, Fig. 4*A*, and is the diameter used in making all the teeth calculations. Circular pitch of a gear is the distance from the center of one tooth to the center of an adjacent tooth measured on the pitch circle, Fig. 4*B*. Diametrical pitch is the number of teeth per inch of pitch-circle diameter.

Clearance is the distance between the top of one tooth and the bottom of the space between the two teeth with which it meshes. Backlash is the difference in the space between two adjacent teeth and the thickness of the tooth that meshes with them. The flank of a tooth is that part of the working surface below the pitch circle. The face of a tooth is that part of the working surface above the pitch circle, Fig. 4*B*.

Spur Gears

A spur gear is the simplest type, having straight teeth cut parallel to its shaft, Fig. 5. In this type not more than two teeth are in mesh at any one time and load is transferred from one tooth to another very quickly. Because of this action, spur gears are limited to comparatively slow speeds and are inclined to be noisy in operation. They are used, however, very extensively on many applications where a reliable slow-speed drive is required.

Helical gears, Fig. 6, have teeth that form part of a helix. In this type of gear several teeth are in mesh at the same time. The teeth mesh at one end and gradually roll together and break contact at the other end. Because of this action helical gears are generally quieter than spur gears. On the other hand, an end thrust is produced by one gear tending to push the other axially.

Herringbone Gears

End thrust on the bearings of helical gears can be avoided by combining two gears, one with a right-hand lead and the other with a left-hand lead, Fig. 7. This type is known as a herringbone gear. Properly designed and cut herringbone gears are excellent, but must be kept in perfect alignment. Any slight endwise movement of one gear by the other throws them out of proper mesh in a way that unloads one side and overloads the other. This difficulty may be overcome by mounting the gears in bearings that will hold them in rigid alignment and by connecting the gears to the power source and load with flexible couplings that will prevent external thrust being transmitted to them.

Another method of keeping the gears in proper mesh is to permit either the pinion or the gear to float so that one may follow the other, the V-shaped teeth then mate up correctly and equalize the load. Herringbone gears should not be operated in a vertical position, because

any wear in the bearings tends to throw the teeth out of proper mesh.

Bevel gears, Fig. 8, permit driving two shafts at right angles to each other. In this drive the axis of the two shafts must be in the same plane. The gear teeth are straight and placed so that their center lines form a cone with its apex on a projection of the shaft axis. Because of the difference in the inner and outer periphery of the gears the teeth are thicker at their outer than at their inner ends. In their action these gears operate like spur gears in that they have not more than two teeth in contact at any one time.

To get a bevel-gear approaching in performance that of a helical gear, the spiral bevel gear, Fig. 9, was developed. It is evident from the figure that the teeth are curved and do not point toward the center of the shaft. Bevel gears have teeth that are sections of a cone; in Fig. 9, the teeth are part of helices around the surface of a cone. Skew bevel gears, Fig. 10, have straight teeth, but skewed at approximately the same angle as the spiral-bevel design. A hypoid gear is a form of bevel design that has the axis of the pinion shaft below or above the axis of the gear shaft.

Where large speed reductions are required in a single step or a right-angle drive is desired, worm gears are frequently used, Fig. 12. The worm always connects to the power source and the gear wheelshaft to the load. With a single thread on the worm the gear wheel moves one tooth for each revolution of the worm. A single-thread worm meshing a 50-tooth gear therefore gives a 50 to 1 speed reduction. A worm and gear inherently gives a high-speed reduction.

To obtain lower speed reduction from a worm-and-gear, multiple threaded worms are used. Fig. 12 shows a worm with 10 threads meshing into a 32-tooth gear wheel to give a speed reduction of 3.2 to 1. If we continue the process of increasing the number of threads on the worm until they become equal to the teeth in the gear we get what is known as a spiral gear, Fig. 13, also used as a right-angle drive.

Internal Gears

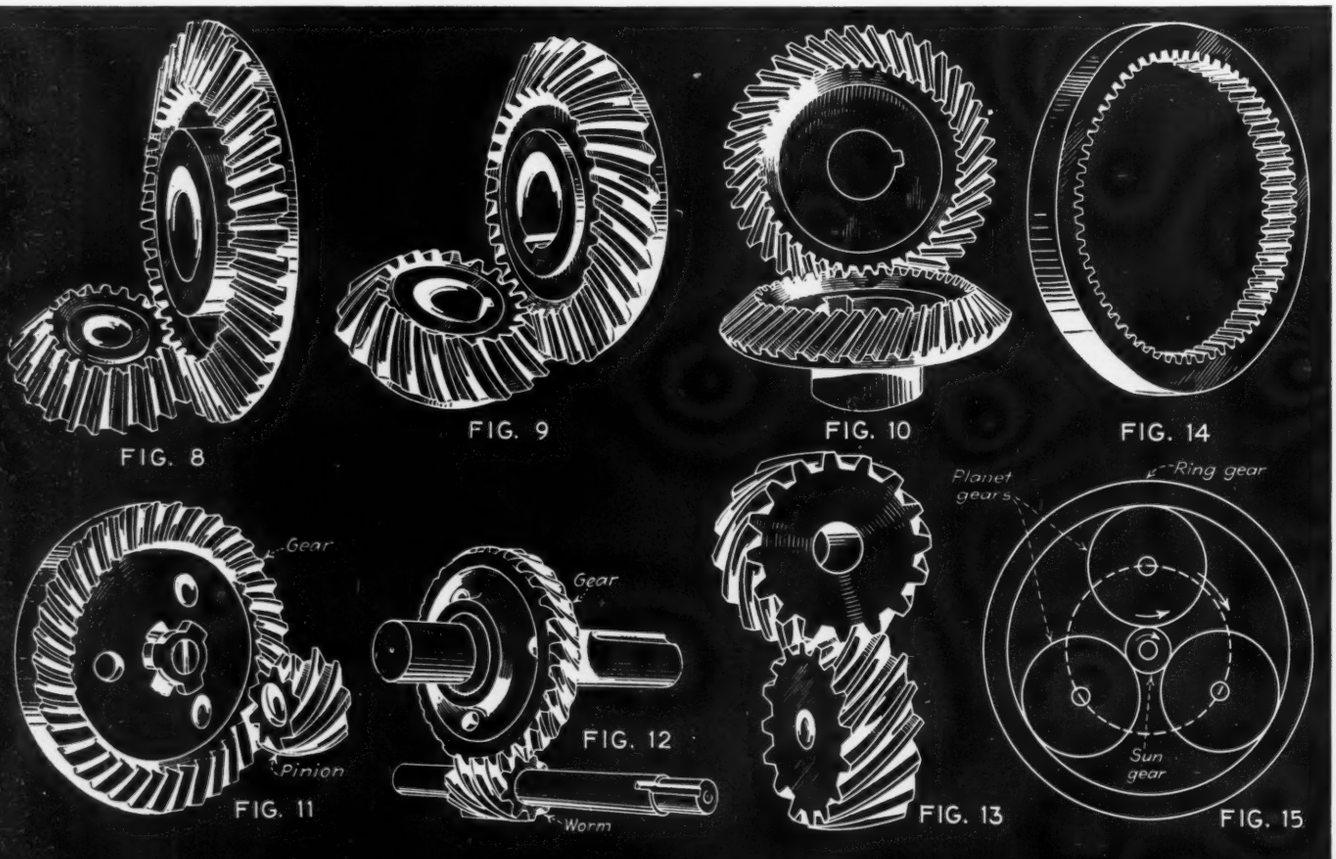
What are called internal gears, Fig. 14, have been used quite extensively. In this design the main gear has its teeth cut on the inside of the rim instead of the outside. These gears have the advantage of being more compact, operate smoother, and their teeth are stronger than in comparable external spur gears. Both gears also operate in the same direction, where external gears run in opposite directions.

Spur or helical gears may be assembled in a planetary arrangement, as in Fig. 15. The center or sun gear is keyed to the motor shaft and driven by it. Supported in bearings in a cage that connects to the output shaft, the three planet gears mesh into the fixed ring gear. If the sun gear turns in a clockwise direction, the planet gear will turn counter clockwise and rotate around the ring gear clockwise. That is, both the input and output shafts turn in the same direction. Another feature of this type of gear unit is that the input and output shafts have their axes in the same straight line.

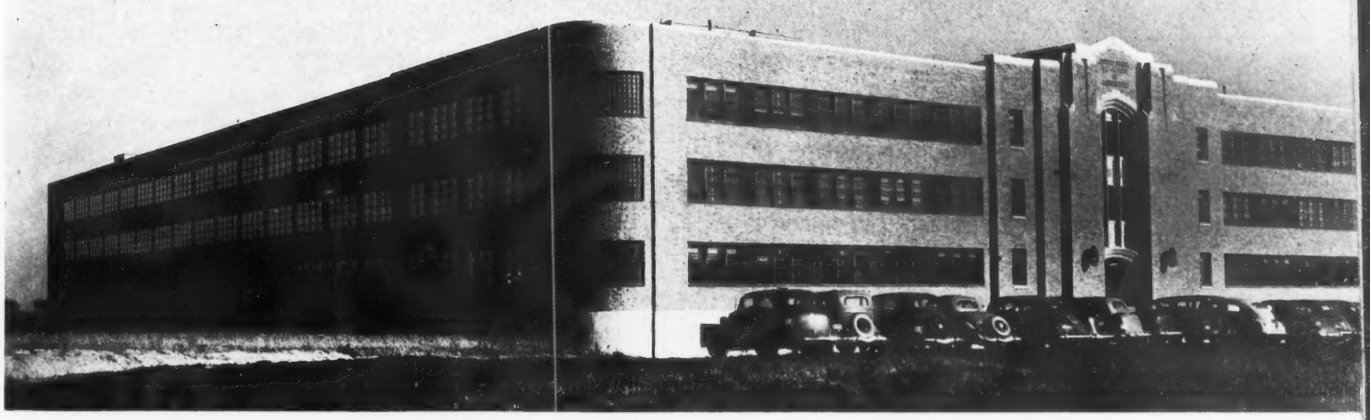
Many special forms of gears are available, but the ones shown are those most commonly used in power-transmission work. Earlier types of gears operated at comparatively slow speeds, were large, bulky, noisy affairs and frequently operated without a protecting case. The pinion or worm of modern reduction gears may operate at several thousand rpm, the gear assemblies are compact, housed in strong, oil-tight, cast-iron cases of great rigidity and supported by liberal-sized bearings to maintain close alignment of the gears. They are provided with ample means of lubrication and single-reduction gear units may have an efficiency of over 98%. To further conserve space, the speed reduction gears and driving motor are often combined into a single unit, known as a gearmotor.

Modern gears are assembled in almost an infinite number of forms and are generally known as speed reducers. Spur, helical or herringbone gears may be combined in single, double and triple reductions with speed reduction up to about 7 to 1 in the single units up to over 500 to 1 for triple-reduction units.

Fig. 8—Bevel gears. Fig. 9—Spiral gears. Fig. 10—Skew gears. Fig. 11—Hypoid gears. Fig. 12—Worm and gear. Fig. 13—Spiral gears. Fig. 14—Internal gear. Fig. 15—Outline of a planetary gear



Surpluses to Synthetics



Typical U-shaped structure with administrative unit at base and with chemical and industrial laboratories in wings; boilers and refrigeration equipment, housed in separate building, provide "sinews" of research

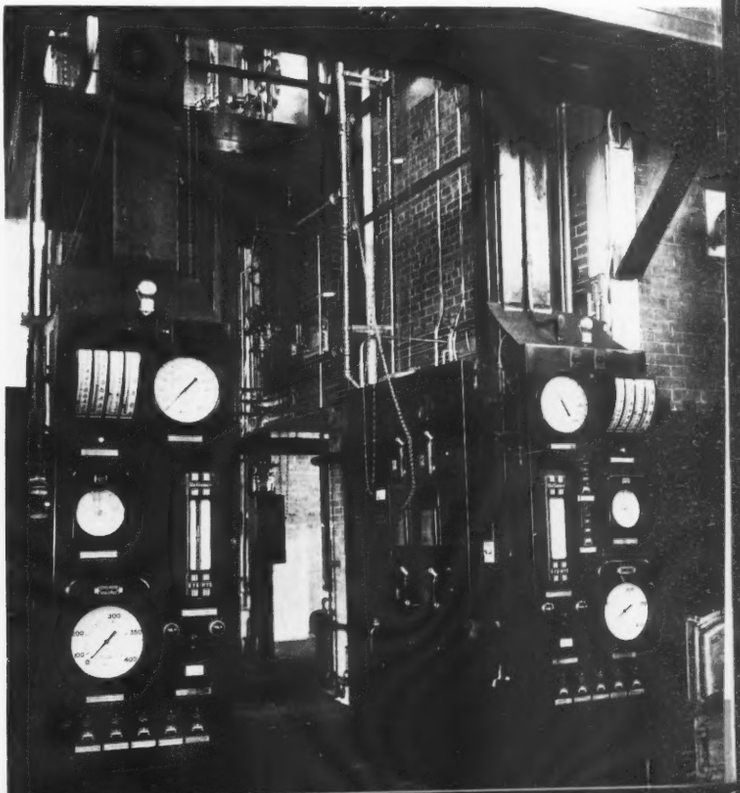
Finding ways to turn starches, proteins, fats, and cellulose of farm surpluses into useful and potentially profitable synthetics such as fuel alcohol and plastics is the job of four new regional laboratories created by the Dept of Agriculture under the Agricultural Adjustment Act of 1938. Situated at Wyndmoor, Pa.; Peoria, Ill.; New Orleans, La.; and Albany, Calif., each includes a modern laboratory building and separate power house.

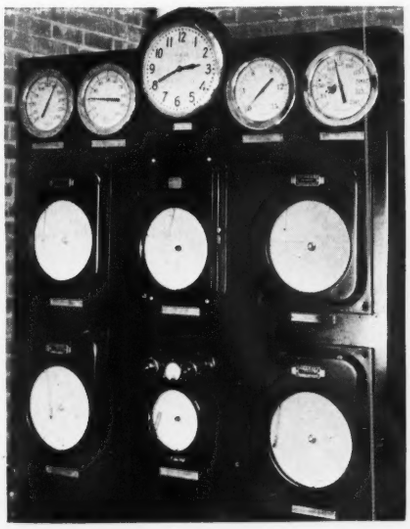
▶ AT THE EASTERN LABORATORY, Wyndmoor (Philadelphia), Pa., a comprehensive metering and control installation helps secure maximum efficiency in the stoker-fired boiler plant, according to N E Carr, mechanical superintendent. Three 2000-sq-ft 125-lb boilers generate steam for process and heating. Operation is entirely automatic; in the Hays metering combustion-control system, a master steam-pressure regulator, reacting to boiler load, adjusts fuel-feed and air-flow controls. These, in turn, control stoker feed and inlet damper position of the forced-draft fan. A furnace-pressure regulator controls the induced-draft fan. Combustion-control instruments are mounted on individual panels, at the side of each boiler.

Fully equipped and well-arranged boiler panels assist operators. Each panel contains CO_2 recorders to give a continuous record of combustion efficiency and provide data for comparative analysis of fuels. Multi-pointer draft gages give a running picture of furnace and boiler conditions, and the Reliance remote-reading gage glass in effect brings the drum down to the operating floor. Cochrane steam-flow meters complete the panel instrumentation, providing records of each boiler's steam output, the basis for any efficiency check.

A main boiler-house panel board mounts Cochrane flowmeters and temperature recorders, Bristol pressure recorder, Lonergan pressure gages and an Ess smoke-density recorder and alarm.

Completeness and convenient arrangement mark individual boiler panels, which include 4-pointer draft gage, pressure gage, CO_2 recorder, steam-flow meter, remote-reading water gage, and control switches. Panel at side of boiler carries combustion-control equipment



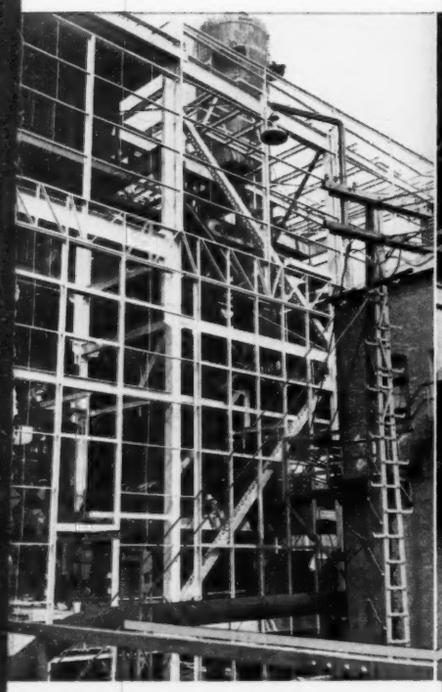


Main boiler-room panel carries water-flow meters, pressure and temperature recorders, pressure gages, and a smoke density recorder and alarm

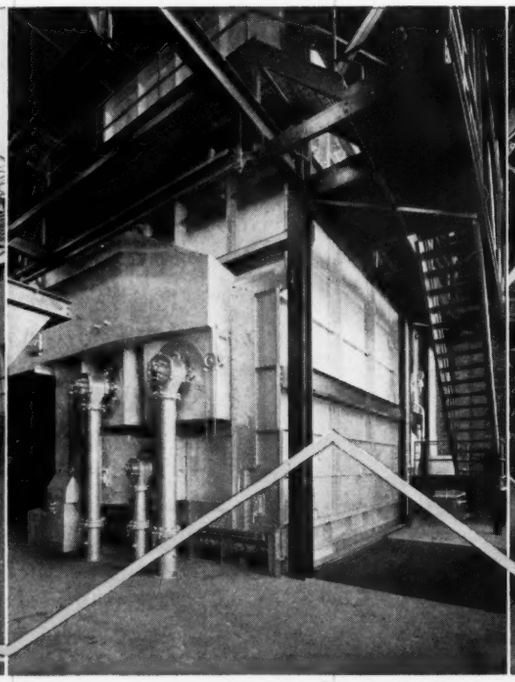
QUALITY PRODUCTS

Riley Boilers sold in 1940 will produce almost eight times as much steam as those sold in 1931—an increase in sales over three times as rapid as the total boiler industry. This tremendous increase in Riley Boiler sales was accomplished without increasing the sales organization or advertising expenditures. Performance, quality design and workmanship, and satisfied users made possible this growth.

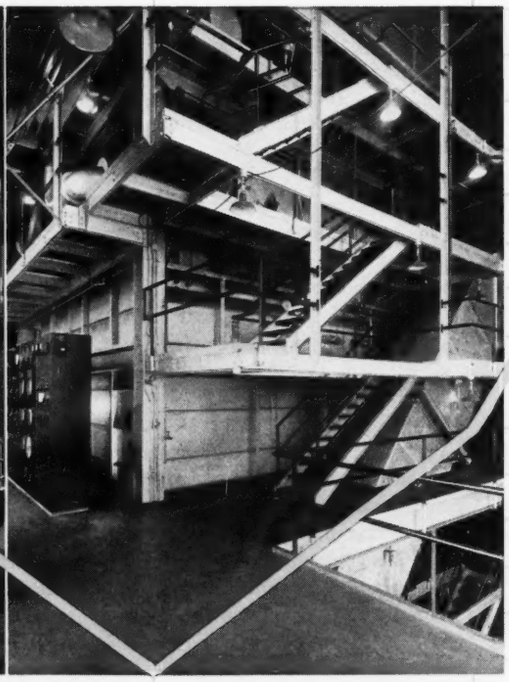
Many of the country's leading industrial and central station organizations swung to Riley equipment during the past decade. The 675,000 pounds per hour Riley Boiler recently purchased by the City of Los Angeles is by far the largest boiler west of the Rockies. Riley is now installing the biggest boiler in the steel industry.



450,000 lbs. per hour Riley Boiler Unit under erection—the largest unit in the steel industry.



75,000 lbs. per hour Riley Boiler Unit. Union Public Service Co. Canby, Minn.



300,000 lbs. per hour unit at Central Illinois Light plant. This company is now installing a 375,000 lbs. per hour Riley Unit.

1931 1932 1933 1934 1935

THESE REPRESENTATIVE REPEAT ORDERS HELPED TO

Winchester Repeating Arms Co.
Central Illinois Light Co.
Norton Company
General Motors Corp.
W. Va. Pulp & Paper Co.
University of Minnesota
Standard Oil Co. of N. J.
Papec Machine Co.
Republic Creosoting Co.
Humble Oil and Refining Co.
Shell Oil Co.
Carnegie-Illinois Steel Co.
Celanese Corporation of America
Imperial Paper & Color Co.
Standard Oil Co. of Calif.
St. Croix Paper Co.
Houston Lighting & Power Co.
Central Ohio Light & Power Co.
Curtiss-Wright Corp.
American Water Works & Elec. Co.
Ohio Salt Co.

TRADE MARK Rx REGISTERED

RILEY

STOKER CORPORATION, WORCESTER, MASS.

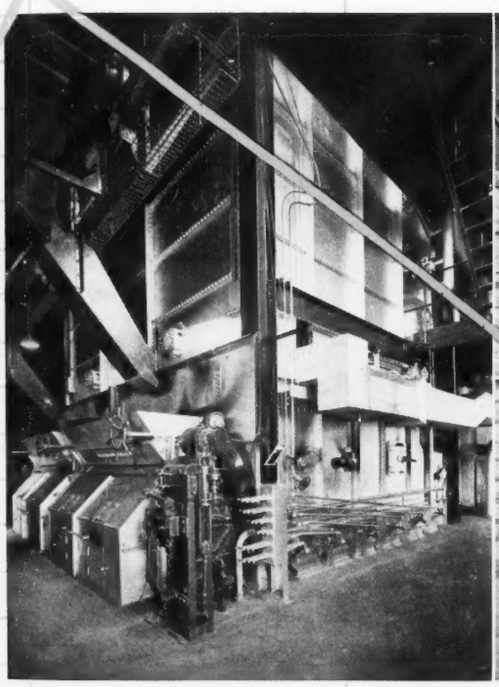
Boston New York Philadelphia Pittsburgh Buffalo Cleveland Detroit Tacoma Baltimore Milwaukee Denver St. Louis Cincinnati Houston Chicago St. Paul Kansas City Los Angeles Atlanta Memphis New Orleans

It will pay you to visit modern Riley Installations

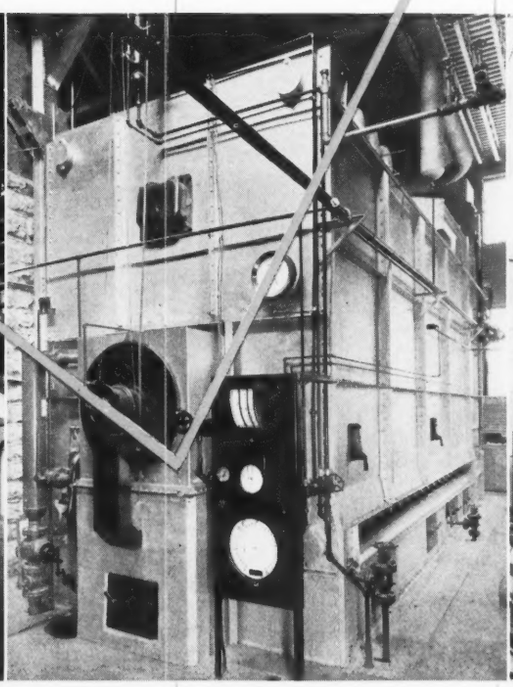
chart their own sales curve

Practically every company which ordered Riley Boiler equipment in the past decade, ordered additional Riley Boilers when increased capacity was required for that plant. Commonwealth and Southern, Scovill, Curtiss-Wright, Electric Bond and Share, Celanese, Masonite, Winchester, Dow Chemical, have all placed repeat orders for Riley Boilers within the past year.

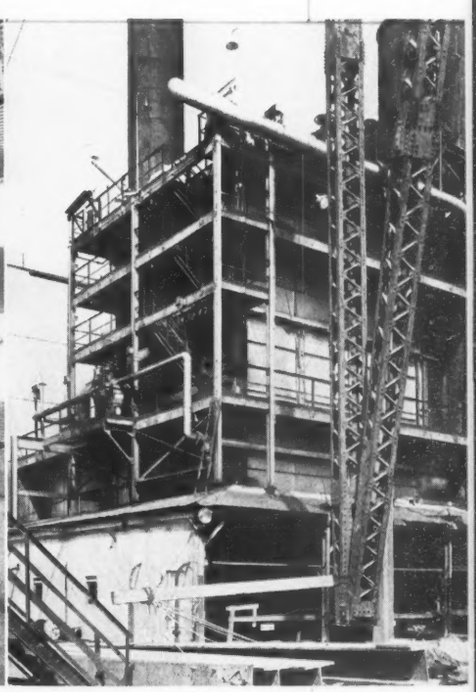
Sales of a product just don't jump like Riley Boiler sales have without a good reason. This reason will be obvious to you if you visit a number of Riley Boiler installations. You can't keep a good man down and it is just as true of a good product.



The country's outstanding lignite burning installation—Otter Tail Power Co., Wahpeton, N. D., 130,000 lbs. of steam per hour.



In the small boiler field it's the Riley "RO" Boiler, 25,000 lbs. per hour unit at the Rochester Dairy Company.



350,000 lbs. per hour unit—Humble Oil & Refining Company. Erection of second 350,000 lb. unit being started.

1936 1937 1938 1939 1940

SWING THE RILEY BOILER SALES CURVE UP . . .

Scovill Mfg. Co.
North Dakota Power & Lt. Co.
Masonite Corp.
Natrona Power & Lt. Co.
J. S. Abercrombie Co.
Geo. O. Jenkins Co.
Revere Copper & Brass Co.
Otter Tail Power Co.
General Aniline Works
U. S. Gypsum Co.
Refined Syrups & Sugars Inc.
Pet Milk Co.
U. S. Military Academy
Carbide & Carbon Chem. Co.
Beechnut Packing Co.
Dow Chemical Co.
Frankfort Arsenal
U. S. Navy
Smith Paper Co.
Publicker Comm. Alcohol Co.
Crown Cork & Seal Co.

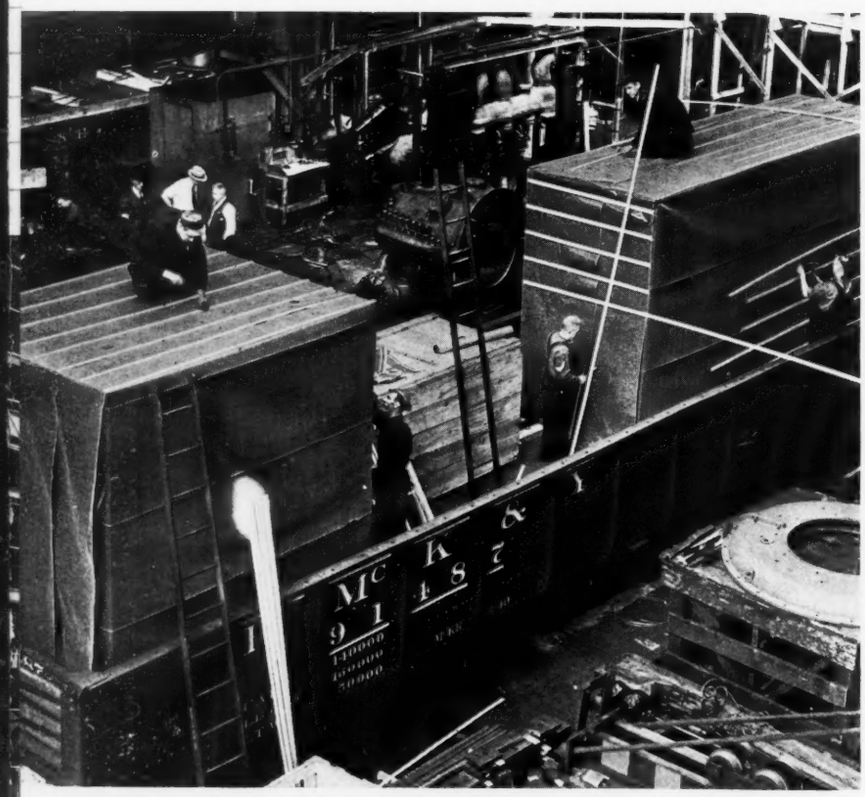
A survey of your power plant by a consulting engineer will possibly show ways of making surprisingly large savings in power costs

COMPLETE STEAM GENERATING UNITS

BOILERS • PULVERIZERS • BURNERS • STOKERS • SUPERHEATERS • AIR HEATERS
ECONOMIZERS • WATER-COOLED FURNACES • STEEL-CLAD INSULATED SETTINGS • FLUE GAS SCRUBBERS

before purchasing Boiler or Fuel Burning Equipment

Installing an Industrial Turbine-Generator



1—The Gates Rubber Co turbine-generator went out of the GE Works like this. Note that loading and crating is done on a gondola car in the shop

▶ IN THESE DAYS when many industrials are buying or considering new power units, this photostory of some of the steps in installing a 5000-kw turbine-generator at the Gates Rubber Co plant, Denver, Colo., is newsworthy—particularly so in view of the short time required for the job. About 30 working days is the normal installation period for a unit of this size; in this case, only 15 working days elapsed between the time the turbine-generator was received and completely installed.

As customary, the Gates Rubber unit was put into service under the supervision of the manufacturer's district turbine-installation expert. Foundations are made ready prior to shipment of the machine. When the unit arrives, the soles plates are properly placed and leveled. Approximately 1-in. space is left between the top of the foundation and the sole plate for grouting.

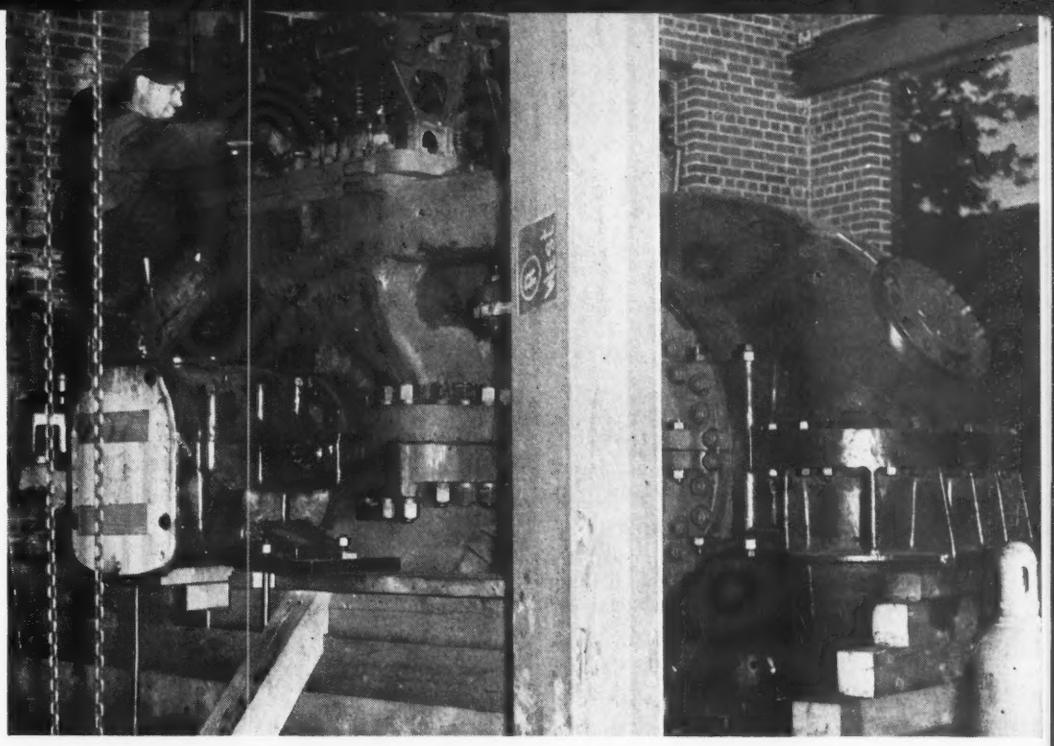
Next, the heavy stationary parts are placed on the sole plates. When this is done, engineers install the field and finish up the all-important job of alignment.

When grouting is completed, the steam, water and oil connections are made, and the condenser and extraction lines are hooked up.

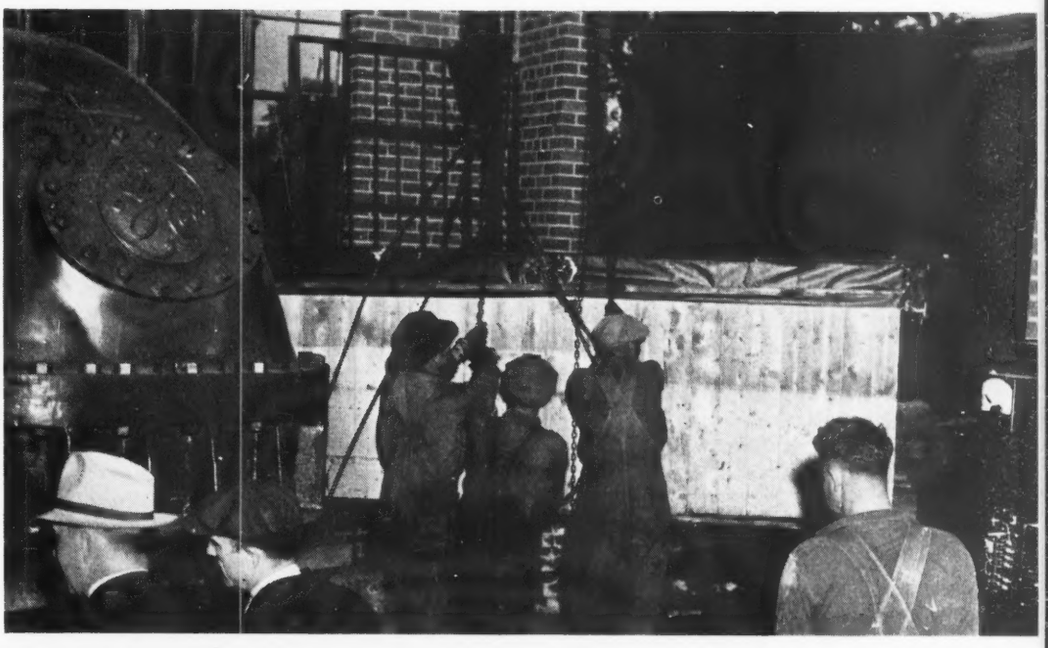
Assembly of lagging is the next step. Then the lubricating system is carefully checked and the lube oil put in. After the generator has been tested for proper insulation resistance, the complete turbine-generator set is ready to be brought up to speed and put on the line.

2—Generator sole plates are being leveled prior to grouting

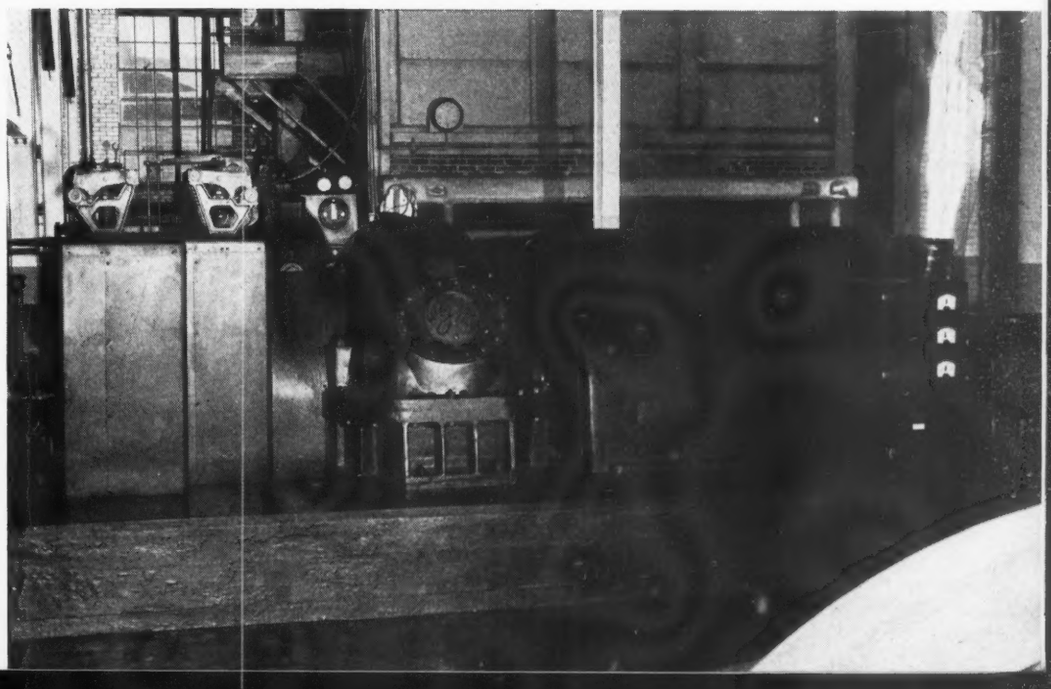
3—The turbine is being skidded onto the foundation. This unit was shipped as shown although larger turbines must usually be disassembled to meet railroad clearances



4—Workman tightens a control valve stand on the steam chest. To set the turbine down on its foundation the wooden skidding will be removed. Then, after alignment is completed, the machine will be grouted and connections to the steam lines and condenser will be made



5—After the turbine and generator are set, the generator field will be installed. Here it is shown being brought into the plant in its shipping crate. When it is in place, final alignments between the rotating elements of the turbine and generator will be made



6—Here is the turbine-generator unit—a single automatic-extraction, condensing, General Electric machine, designed to supply process steam at any pressure between 100 and 125 lb—all shipshape and operating

Piping and Control for Unit Heaters

After spending time and thought on selecting and locating your units, don't miss the boat on piping and control. Here are practical pointers on both of these important considerations

▶ To get the most out of unit heaters requires proper piping layout and a control hookup that fits the job's needs. Failure to carry through on these installation details can entirely wipe out all the time and thought spent in selecting and locating the units. General principles are simple; the makers give explicit directions for proper installation of their own units.

Regardless of the type of heating system to which the unit heater is piped, the engineer must: (1) allow for expansion and contraction, and anchor all piping independently of the heater, (2) avoid draining the end of a steam main or a long branch through the heater, by use of a separate drip, (3) connect supply branches to top of main and pitch line down from heater connection to main (on steam systems), to prevent line condensation from flooding heaters, (4) install a gate valve in the supply branch, for positive shutoff, and (5) install a strainer in the supply branch where foreign material is likely to be encountered.

In closed 2-pipe gravity systems, there is a definite steam pressure in

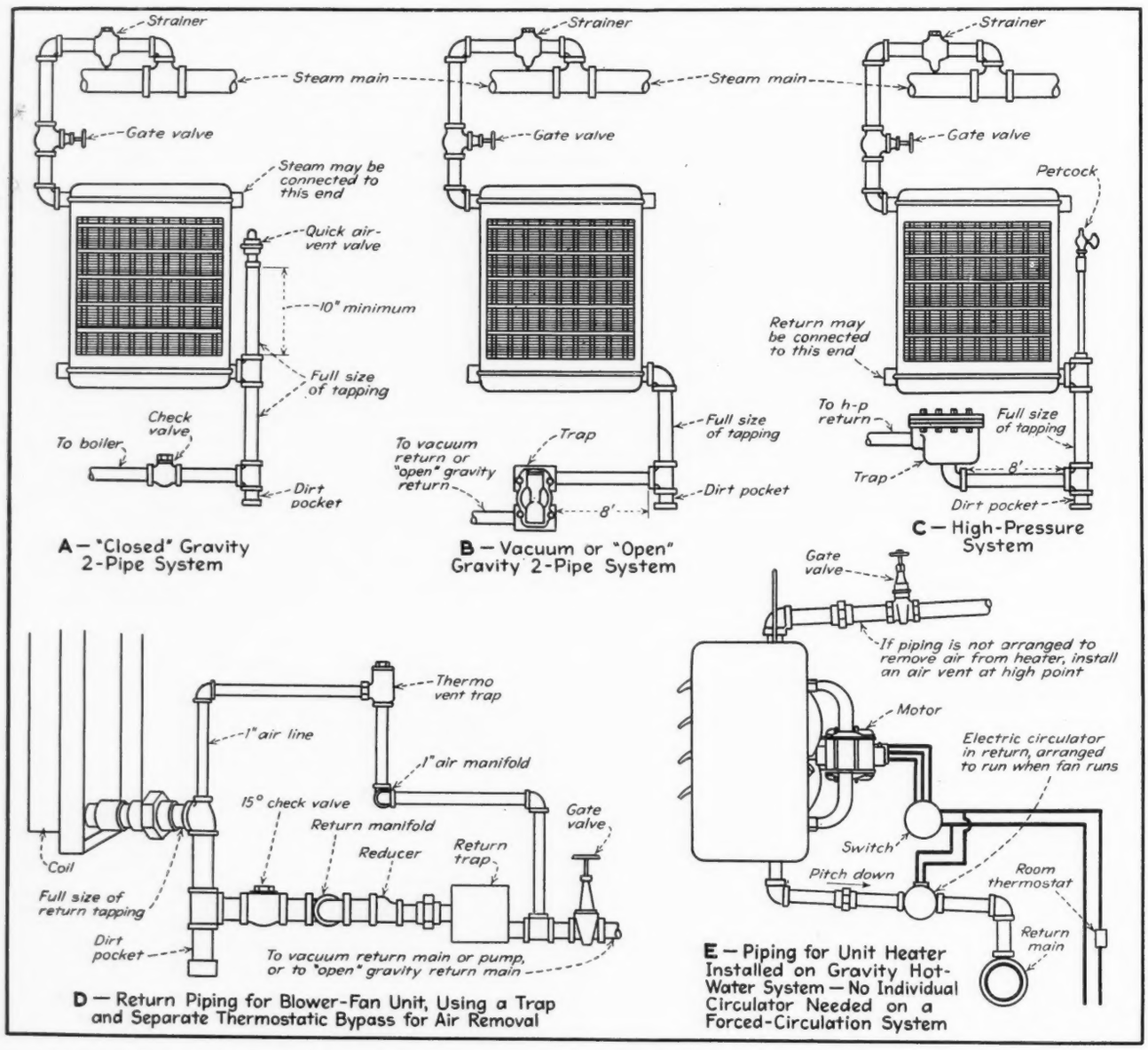


Fig. 1—Typical piping layouts for unit heaters; same principles apply to all types although actual arrangements differ

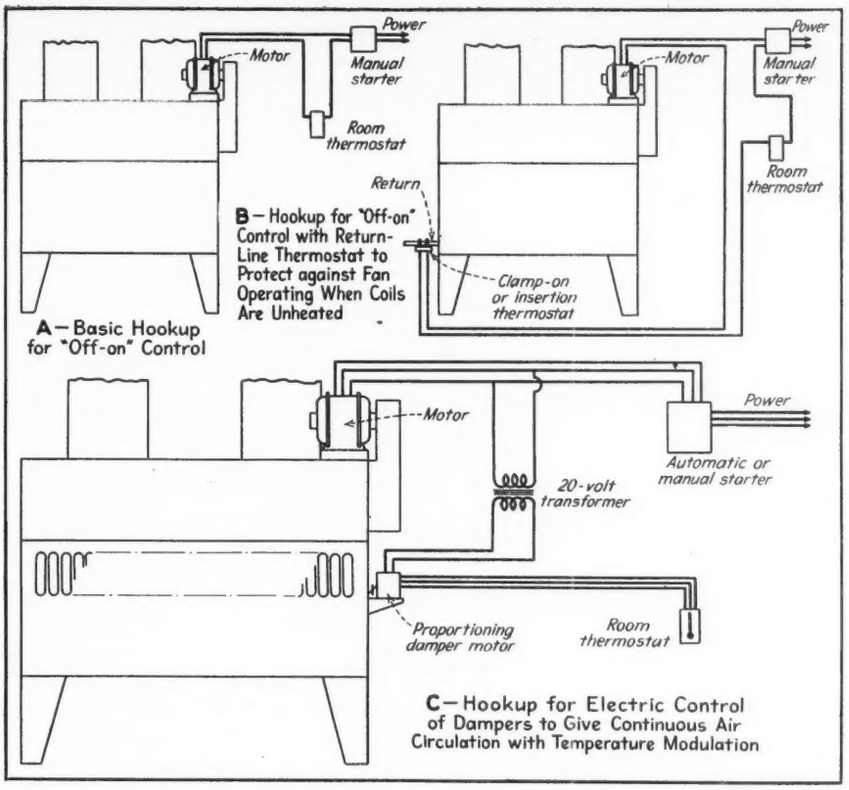


Fig. 2—Three hookups for automatic control; *A* and *B* show single-phase circuits and *C* shows 3-phase circuit with motor starter. Basic principles apply to all types

the return main, and this pressure, together with the static head between main and water level, returns condensate to the boiler without mechanical means. On such a system, the return-side piping looks like that in Fig. 1A. A swing check valve controls return of condensate and a vent valve insures removal of air. A gate valve may be installed in the return connection, if desired. Regardless of the type of system connected to, the return line should include some form of sediment or dirt pocket, accessible for cleaning. Continued operation of the fan, after steam supply stops, creates a vacuum in the unit; if the air valve will not relieve the vacuum, a vacuum breaker should be installed. This may consist of a 15-deg light-weight disk check, installed at the base of the air valve with disk shutting against steam flow.

2—*Pipe Gravity Systems*

In open 2-pipe gravity systems, there is no pressure in the return main, and condensate flows by gravity to a receiver or hotwell from which it is pumped into the boiler. In vacuum systems, a mechanically operated vacuum pump keeps the return main at pressure less than atmospheric and removes air and condensate from the heater. Two trapping functions are involved in either system: (1) removal of condensate without loss of steam, and (2) removal of air without loss of steam. These jobs can be performed by a thermostatic trap, by a combination float and thermostatic trap, or by a conventional float or bucket trap for condensate removal and a thermostatic bypass for air removal.

Within the capacity range for which they are available, thermostatic traps may be used on unit heaters provided a cooling leg of sufficient length is installed to lower condensate temperature and keep the trap partly or fully open while the heater is in operation. One type of unit heater has a built-in cooling leg, which simplifies installation. Where large discharge capacity is required, either a float-and-thermostatic trap (Fig. 1*B*) or a trap with thermostatic bypass (Fig. 1*D*) will do the job.

Except that pressure exceeds 20 lb, the so-called high-pressure systems closely resemble open 2-pipe gravity systems. Within the range of sizes and pressure ratings available (usually up to 150 lb) either a thermostatic or float-and-thermostatic trap may be used, or the thermostatic bypass hookup shown in Fig. 1*D* may be employed. A common arrangement, particularly for higher pressures, includes a float or bucket trap suitable for the pressure, and a manually operated petcock for air removal (Fig. 1*C*).

Unit heaters, because of the high heat-transfer rates resulting from forced circulation, produce deceptively large quantities of condensate. For this reason, it is vitally important to choose traps of adequate size. In general, the trap selected should be able to handle at least twice the condensing capacity of the unit, under the most severe conditions of operation (lowest entering air temperature, maximum steam pressure and maximum fan speed). Use a separate trap for each heater to avoid short-circuiting. Remember that trap orifices are designed for specified pressure drops; be sure traps are big enough to handle condensate at lowest likely pressure. Whenever possible, install traps below heaters; if condensate drains away from the trap by gravity, the trap discharge should always be below the bottom of the heater.

Hot water forms a suitable medium for unit heaters but forced-circulation is required. Pipes must be sized, connected and arranged to insure proper flow to each unit. Air valves or reliefs must be provided. The system should be laid out and installed so that in case of a shutdown in cold weather, all water may be drained to prevent freezing. Good practice indicates the inadvisability of using hot-water in unit heaters installed where air at temperatures below freezing may enter the heater, unless provided with means for mixing re-circulated air to bring the mixture temperature above freezing. To connect a unit heater in a gravity hot-water system, use a motor-driven circulator as shown in Fig. 1*E*. This is wired to start and run with the fan.

Basic Control Hookup

Naturally, manual control for unit heaters is simplest and cheapest, but a measure of automatic control may be provided for a relatively small investment. The basic control hookup (Fig. 2*A*) involves a room thermostat which controls starting and stopping of the fan motor. Steam is supplied to the unit continuously, at constant pressure. During the periods of fan shutdown, the heat output of the heater is so small as to make this arrangement practically the equivalent of "off-on" operation. In this hookup, as in most of the others that follow, the thermostat may control one or more heaters and may be used directly or in conjunction with a motor starter, depending on the motor sizes involved and whether the circuit is single- or 3-phase. For simplicity, diagrams 2A and 2B show single-phase hookups, without starters.

A single-room thermostat may con-

trol all unit heaters in a given space but such an arrangement usually leaves something to be desired as to closeness of control in all parts of the room. A better arrangement is to use separate thermostats for groups of unit heaters; the zoning principle may be applied by grouping units in parts of the space exposed to approximately similar conditions of wind, sun, etc. Under certain conditions, individual thermostats may be used; one manufacturer supplies a packaged unit for this purpose, consisting of an adjustable thermostat arranged for suspension from the fan motor. No wiring other than plugging-in to the motor conduit box is required. The thermostat can be set according to personal comfort observations or by comparison with a thermometer located in the working zone.

Where there is a possibility of steam-supply failure, precautions must be taken against blowing cold air, as would happen if the fan ran with the steam shut off. This possibility can be prevented by using a clamp-on thermostat on the return line, wired in series with the room thermostat (Fig. 2B), or a pressurestat hooked up the same way. If steam is supplied intermittently, under centralized manual or automatic control, these two "indirect" control arrangements can be used to regulate fan operation.

2-Thermostat Control

For use with unit heaters of the vertical-blow or projection type, one manufacturer offers a control system employing two thermostats, one close to the floor, the other near the ceiling. The floor thermostat controls a steam valve; when it calls for heat, the valve opens and steam flows to the heaters. This floor thermostat likewise starts the fan motors. When the floor thermostat is satisfied, it shuts off the steam, but the fans remain in operation, circulating the heated air lying close to the ceiling. The ceiling thermostat shuts off the fans when temperatures at floor and ceiling have been approximately equalized.

Variations on the conventional thermostatic control setup include thermostats designed for use with 2-speed motors and 2-level thermostats for day-night operation. In the former, the heater operates at full speed until room temperature rises to within a few degrees of the thermostat setting, when the motor is switched to slow-speed. When the room comes up to temperature the motor stops and as the room cools, a reverse cycle takes place. With this control, full speed comes into use mainly for pickup and for abnormal temperatures; most of the time the unit alternates between "off" and "slow-speed." Such an arrangement tends to give more continuous air circulation, cutting down temperature fluctuations and reducing stratification.

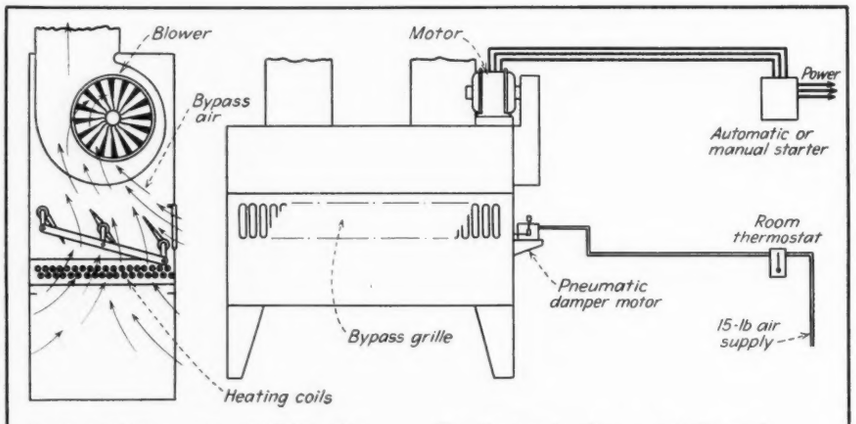
The 2-level control can be applied to a single room but biggest gains come from utilizing its facilities for remote control of temperatures in all parts of a large plant. A typical installation of this kind would consist of a series of 2-level thermostatic controls, each regulating operation of a group of unit heaters, and a remote-control pushbutton station in a central place. By operating pushbuttons at the individual controls, various floors or parts of floors can be switched from "high" or normal working-day operation to "low" or night operation. Likewise, temperatures throughout the plant are under control of a single responsible individual in the boiler room or other central point.

Modulating Control

All the preceding control setups operate on an intermittent cycle. With certain types of unit heaters, continuous air supply can be obtained, and control is effected by varying air temperature. Many blower-fan units are equipped with face and bypass dampers, Fig. 3A, so that varying mixtures of heated and recirculated air can be sent out in accordance with temperature needs. Fig. 2C shows a room thermostat controlling the damper motor which proportions heated and recirculated air, and Fig. 3B represents a similar arrangement with a pneumatic damper motor. A clamp-on thermostat in the return line, or a pressurestat, can be used with this hookup to prevent fan operation when steam is shut off. Naturally, units can be zoned or grouped for operation on a single thermostat.

Control by automatic throttling of steam temperature represents another means of obtaining desired temperature with constant air circulation. At reduced flow, condensation occurs close to the entering end of the coil, and if entering air temperature is below freezing there is a possibility of freezing. This difficulty, encountered where a constant supply of fresh air under close temperature control is required, can be solved by using heating surfaces fitted with steam-distributing tubes (see "Modern Unit Heaters," page 642, POWER, October, 1940).

Valve-controlled unit heaters of this type can be installed in 2-pipe steam systems where condensate is returned to the boiler by means of a vacuum pump, boiler-return trap, or pump and receiver. Best results are gained with steam pressure less than 25 lb. Whether fitted with an individual throttling valve or installed on a system already pressure-modulated, the control must be capable of intermediate action; these units are not suited for manual control. In all cases, a low-limit air-stream thermostat in the unit discharge must be wired into the circuit to maintain a minimum air temperature and thus a minimum steam supply. The setting of this thermostat should be as high as practical but not less than 45 F. Outdoor-air and recirculating dampers should be motor-operated and the motor wired to close the outdoor-air dampers when the fan motor shuts down. A return-line thermostat or pressurestat should be used to protect against blowing cold air in case of steam shutdown.



A — Typical Blower-Fan Unit Showing Face-and-Bypass Dampers for Blending Bypass Air and Air Passing Heating Coils

B — Hookup for Pneumatic Control of Dampers to Give Continuous Air Circulation with Temperature Modulation

Fig. 3—Arrangement of face and bypass dampers, and pneumatic control hook-up

Multi-Purpose Feedwater System Serves Steel-Mill Boiler Plant

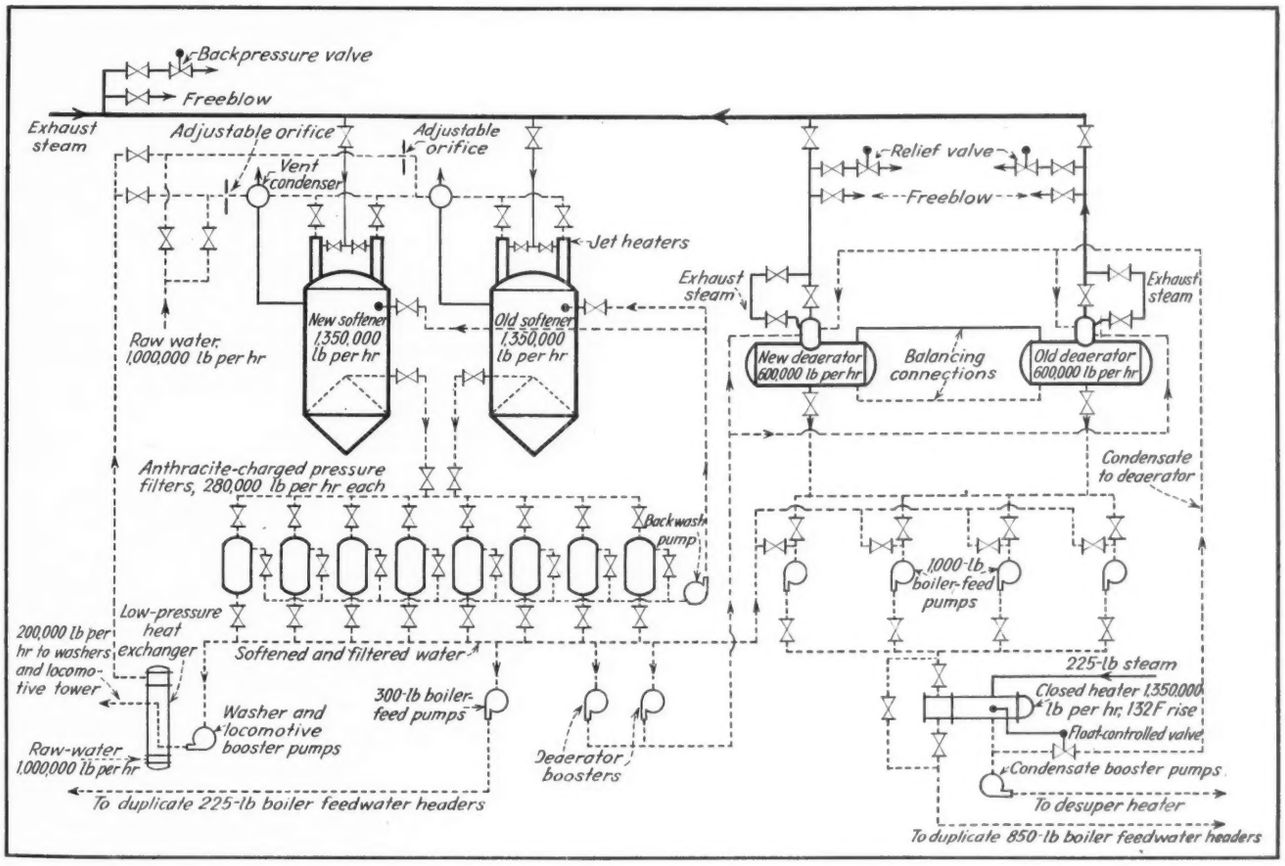
100% extension to softening and deaerating plant serves new 850-lb boilers, supplies condensate to a desuperheater, washes blast-furnace gas with sulphur-neutralizing water, and feeds existing low-pressure steam-generating units

▶ A LARGE STEEL COMPANY has just put into operation a high-pressure boiler-plant addition, which includes a third 400,000-lb-per-hr, 850-lb, 825-F Babcock & Wilcox steam-generating unit. The contract for construction and installation of the entire extension is held by the Dravo Corp, Pittsburgh, Pa. One of the most interesting parts of the addition is the feedwater system, which presents a number of features both in equipment design and piping layout.

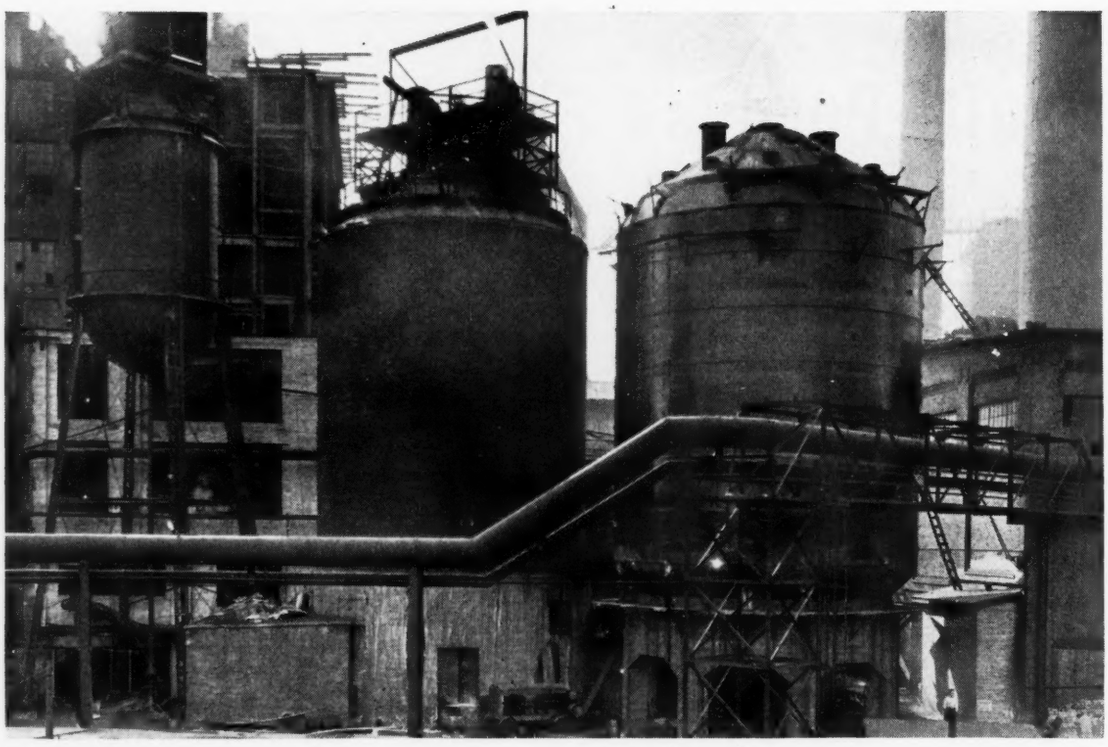
In the equipment, advantage has been taken of modern developments from a standpoint of both simplified operation and improved results. In the piping arrangement, all systems have been duplicated or looped where possible, with generous use of sectionalizing valves, so located that failure of any part of the system cannot throw the plant out of operation. These features, important in any power plant, are extremely necessary at this mill where there is no tie-in with any external power source.

All parts of the feedwater cycle are not yet in complete operation, but there is ample evidence that the system will accomplish the desired results, as the sections now in operation have completely filled their functions. The flow diagram, which gives the size and capacity of the major equipment items in the feedwater system, also illustrates the general hook-up in detail.

In 1926 a Cochrane hot-process softener of 160,000 gph capacity was installed to treat 100% makeup for several batteries of 225-lb, 525-F boilers. The water being handled by this system is Ohio-River water containing acid



Schematic flow diagram shows how duplicate equipment permits shutting down any unit of the feed system without interrupting operation. Not shown are many bypass and emergency piping and valves which insure continuity of service



High-pressure boiler-plant extension, showing existing 160,000-gph softener (left) and new duplicate unit

mine water, silt and organic matter, and silica in addition to an average of 5–6 grains of hardness. The quality of the water produced by the softener has proved suitable for the 225-lb boiler system without further treatment.

When the first high-pressure installation was considered in 1935, the steel company had gained such confidence in the ability of this type of system to provide water suitable for high-rating boilers, that they were willing to attempt its use on high-pressure boilers also. Accordingly, the apparatus was adapted to handle the high-pressure boiler plant by the addition of phosphate equipment feeding to boiler-feed-pump suction, and a zero oxygen deaerator. At this time no important changes in the basic design of the softening system were made.

Duplicate Unit Installed

Increasing demand throughout the years had overloaded the existing softener, so that a softening system, which was already the largest single unit equipment of its type known, was doubled in size by the current installation. While total load has not been doubled, modifications in design of the new equipment, many of which are being applied to the old equipment, will enable either unit to carry full boiler-plant requirements with a high degree of performance. This was desirable so that either unit might carry the complete load in case of outage of the other, and also, since the old sedimentation tank is of riveted construction, all seams and rivet heads will be seal-welded to prevent leakage and embrittlement.

Design improvements include an all-welded sedimentation tank utilizing the latest practice concerning the point of support, plate contours, and structural strength; an adjustable orifice for maintaining accurate chemical control under light loads which may prevail when the two units are running in parallel; a stirring mechanism for more complete mixing of the softening chemicals which has led to better treatment, improved flocculation, and freedom from short circuiting of water flow; and a vent condenser which gives controlled venting and heat saving.

The total filtering capacity has been increased about one-third. All new filters were used except for one recently purchased unit, which was relocated. All filters have been charged with anthracite filtering material, which not only is physically and chemically more suited for feedwater than any type of filtering material previously used, but also makes for simplified operation by permitting omission of the air or steam agitation before backwash.

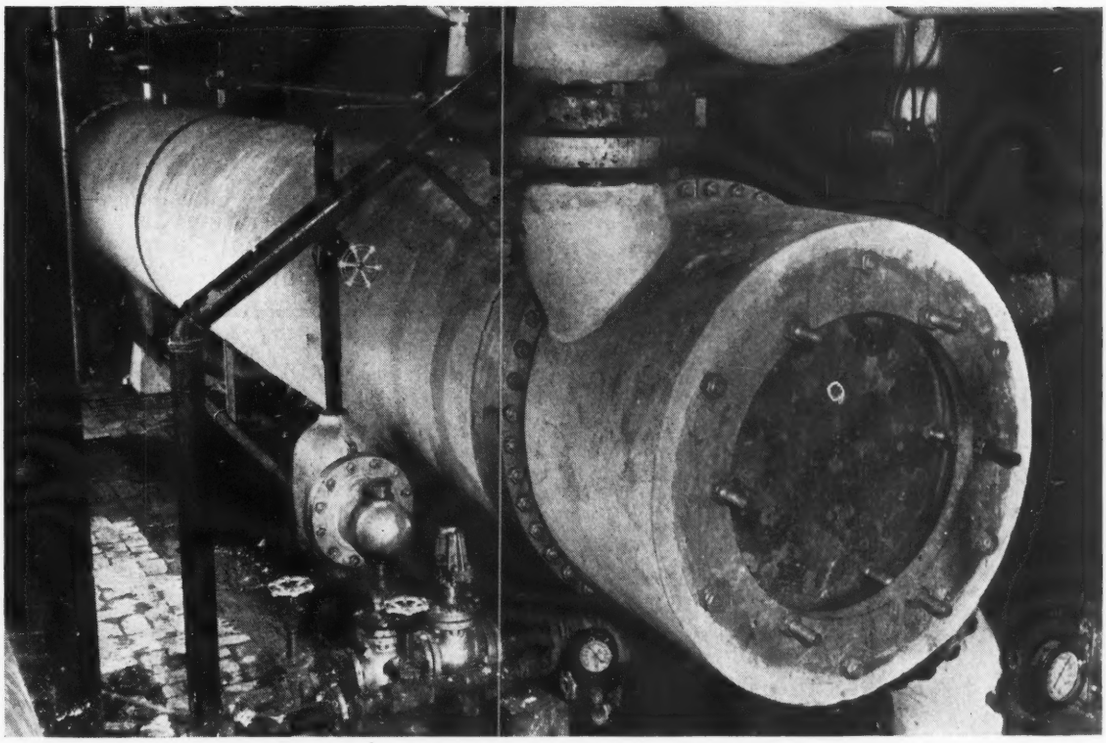
With anthracite, proper bed expansion can be obtained without agitation by utilizing a 12-gal-per-sq-ft back-wash rate. Back-washing is further simplified by use of filtered water, which limits the filter valve nest to three valves. In addition to the benefit of hot soft water for back-washing, this eliminates the necessity for purging the filters to waste, required with the conventional method of washing with unfiltered hot treated water. This method of back-washing is practical only in a bank of several filters, where the increased load due to a large volume of back-wash water is not an appreciable addition to the total load on other filters during the back-washing of one. The filters are in double deck groups of four to conserve space.

Under the 1935 set-up, soft filtered water was fed directly to the 225-lb boilers, but was boosted through a 600,000-lb-per-hr zero deaerator before going to the 850-lb boilers. In addition, phosphate was fed into the boiler-feed-pump suction.

New Deaerator

To boost the deaerating capacity for the increased high-pressure load, a new Cochrane deaerator was provided, an exact duplicate of the existing deaerator in nominal capacity and external size. However, the internal design is such that it can maintain high overload capacities in order to handle the complete boiler-plant requirements in the event of an outage in the old deaerator.

Not shown in the flow diagram is the phosphate system which now feeds directly to the high-pressure boiler drums. This change in hookup was necessitated by the inclusion in the new plant of the high-pressure stage heater, and it was desirable to feed the phos-



4400-sq-ft feedwater heater, with desuperheating, condensing and sub-cooling zones, heats 1,350,000 lb per hr

phate directly to the boilers to prevent the possibility of stage heater deposits.

The stage heater is a Struthers-Wells high-pressure design which has readily removable heads held in place during operation by the water pressure within the unit, thus doing away with the problem of leakage prevalent where there are gasketed flanges with bolts under tension. The heater has a capacity of 1,350,000 lb per hr of feedwater with a temperature rise from 218 to 350 F, based on 60% clean tubes. The heating is accomplished with 225-lb, 525-F steam which is desuperheated, condensed, then sub-cooled to 245 F before leaving the heater.

Use of Condensate

Two adjuncts to the feedwater system are worthy of mention. Part of the valuable condensate from the stage heater is fed through condensate boosters to a desuperheater station, the remainder bleeding to deaerator storage. Use of condensate in the desuperheater leads to better quality steam, and relieves the difficulty encountered through the previous use of feedwater with its solids content which interfered with proper action of the regulating valve.

The old blowdown heat exchanger is now being used to cool, by the use of feedwater on its way to the softener, 400 gpm of water, part going to the locomotive tower, so that it can be handled by the ejectors on the locomotives. This cooled water, which is, of course, softened and has high alkalinity, is also used in the blast-furnace-gas washers, where the alkalinity counteracts the severe corrosive condition which was prevalent when raw river water was used previously in the precipitators.

Continuity of service has been stressed in the piping system. There are three available sources of raw water to the softener, which ordinarily take their supply from one source through the low-pressure heat exchanger. From the sedimentation tank to the filters, in addition to the conventional outlet from the uptake cone, there is a lower outlet directly from the side of the tank which makes available about one hour's additional supply of hot treated water through the regular system.

From the same connection there is an emergency line directly to the high-pressure boiler-feed pumps. This line not only insures a good grade of feedwater in case of complete failure of the filtering and deaerating systems, but has proved its value during the new plant construction.

All lines from the softener to the filter headers are independently valved so that any line can be removed if necessary. This procedure might not be deemed necessary with direct connections to the filters, but it was more convenient to put the filters at some distance from the sedimentation tank. The filtered feedwater line to the various pumps is looped, and the sectionalizing valves so placed in this line that in case of failure in any section of line, full capacity on any one of the branch systems can be obtained at all times. On the all-important high-pressure boiler-feed pumps there are four sources of water available.

Each deaerator is supplied with its own source of exhaust steam from certain selected auxiliaries, so that, under ordinary circumstances, there will be sufficient steam at all times for carrying full load on either deaerator. In addition, the steam balancing line between storage tanks is of such size that it can handle all the necessary transfer in case of all the steam coming from either system and crossing to the other one.

Equalizing of Loads

The equalizing of loads between the two softeners and the two deaerators, which under ordinary circumstances will operate in parallel, is accomplished by using exactly duplicate floats and valves on each unit. Water for the floats is taken from a common point in the water-equalizing lines. In this way, even if the level should stand differently in the two units due to slight variation of steam pressure in the units, they will continue to carry the same share of the load.

The customer and Dravo Corp cooperated in developing the equipment and piping designs to make the feedwater system an example of a thoroughly integrated layout.

THE OPERATING ENGINEER

George Edwards
Advisory Editor

Practical Aids
Maintenance Hints
Questions — Answers

Published monthly as an integral part of POWER

When to Weld for Boiler Repairs

Sometimes it's economical and practical, sometimes it's dangerous —the engineer must know the answers and the reasons why. Covering common boiler repairs, Harry Spring tells whether welding is safe or isn't and, where safe, how it should be handled

▶ WHETHER OR NOT WELDING is permissible is one of the biggest questions in boiler-repair work and a likely question in state examinations for engineers' and boiler-inspectors' licenses. Most of the states adopting the ASME Power Boiler Code as law have individual state regulations dealing with welding in boiler repairs; major points of these rules are quite similar.

The following paragraphs describe a few common boiler repairs where welding is the most practical and economical method to follow and also mentions instances where welding may be dangerous. Remember that a checkup of state regulations should precede any use of welding in boiler repairs. Here's what Rule G-14 of the Pennsylvania Code says on this point: "No repairs to boilers shall be made by welding until after inspection and approval of the contemplated repair by an approved boiler inspector. All such repairs shall be made under the supervision of an approved inspector." Many other states have rules very similar to these.

Of all cracks usually safe to repair by welding, firecracks are perhaps the most common. Firecracks occur where a seam is exposed to direct heat of the fire: for example, girth seams of hrt boilers and furnace-sheet seams of firebox boilers. Such seams are often single-lap riveted and firecracks may appear, extending from the calking edge to the rivet holes or from the calking edge between rivet holes, Fig. 1.

These cracks are caused by over-

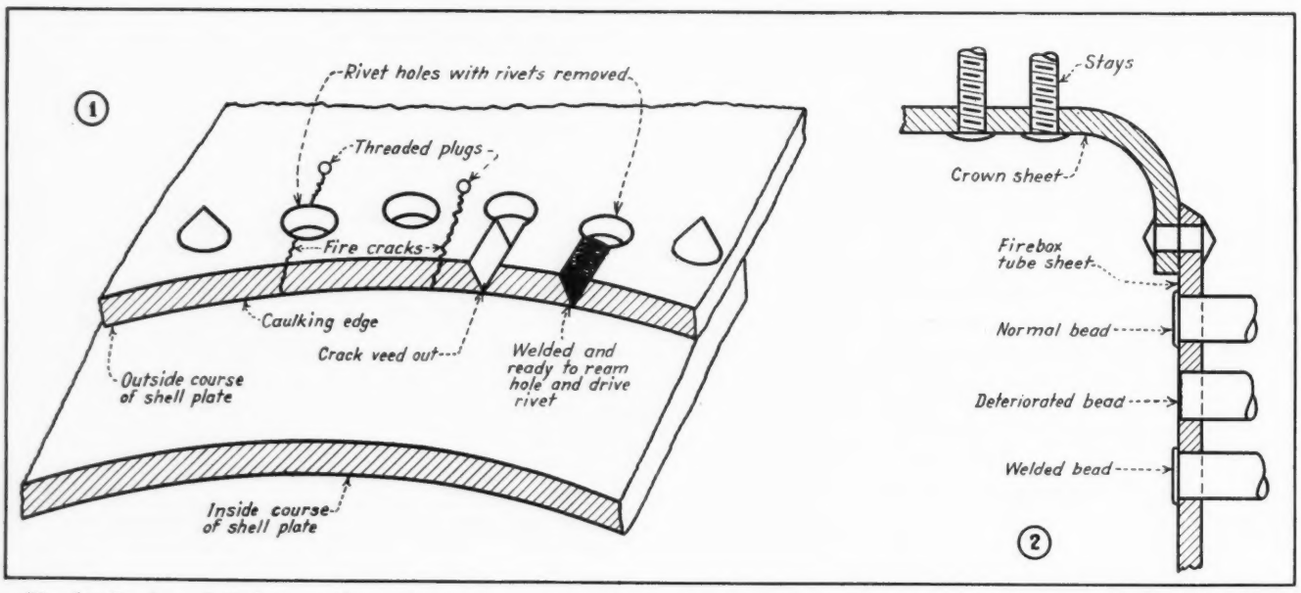


Fig. 1—Section of girth seam shows firecracks and steps in repair. Fig. 2—Repairs to tube beading made by fusion welding

heating, especially in thick plates. A limited number may not be dangerous unless they run from rivet-hole to rivet-hole, or extend more than 3 in. beyond the lap into solid plate. Then, no repairs by welding are allowed. Often it is unnecessary to make repairs until or unless leakage develops.

Fig. 1 shows firecracks in a boiler plate prepared for welding and the completed repair. Rivets should be removed 6 in. each side of the section to be repaired. Cutting vees permits fusion for the entire thickness. Welding is done with coated rods by the electric-arc process. If a crack extends through a rivet hole (Fig. 1) or from the calking edge between rivet holes, drill a ¼-in. hole and tap it for a stud at the end of the crack, in order to prevent extension of the crack. After welding the rivet holes are reamed and new rivets driven.

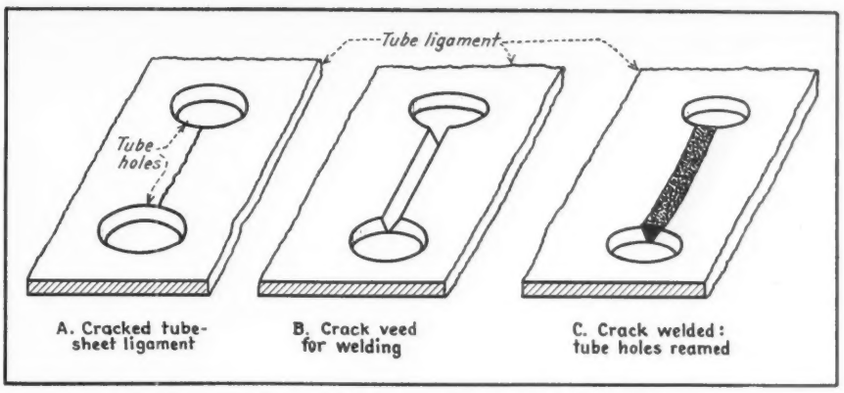


Fig. 3—Three steps in welding repair of tube-sheet ligament crack

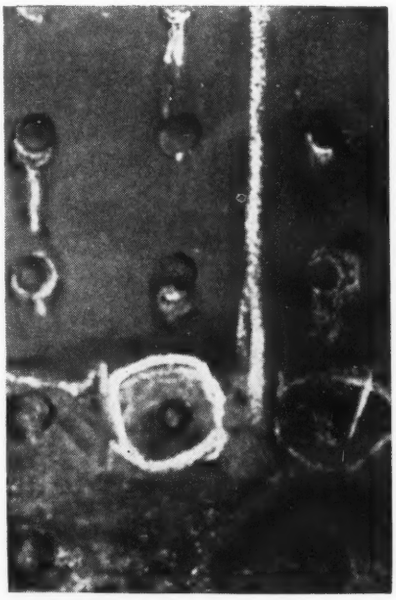


Fig. 4—Circled staybolt on left has burned-off head; hammer test indicates circled staybolt (right) is broken

Tube Beading

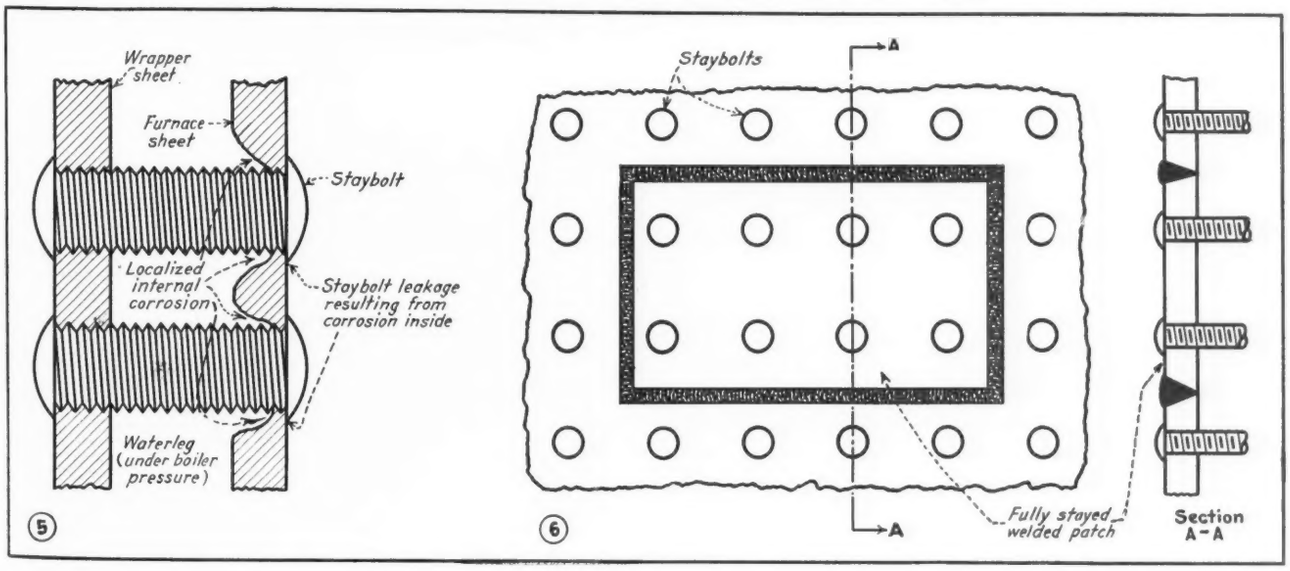
Exposure to severe conditions may cause deterioration of beading on tube ends in some firetube boilers. For example, beading at the firebox end of locomotive or vertical firetube boilers may be wasted due to flame scrubbing. beading at the opposite ends may be damaged from external corrosion caused by soot and moisture.

If the expanded part of the tube is not damaged so as to weaken its grip on the tube sheet, beading may be built up by electric welding, Fig. 2. Before proceeding with such a repair, however, check the condition of the tube. If the condition of the tube makes early replacement seem likely, welding the tube will make removal much more difficult and would not be worthwhile.

Where the tube sheet does not form part of the shell or drum of a boiler but is the type found in locomotive or firebox boilers, a crack between tube holes may be repaired by welding. The tubes will serve as stays and brace the area adequately. To make the repair, remove tubes from tube holes affected and vee the tube sheet for its full thickness. The vee cut is fusion welded, usually by the electric-arc process. Tube holes are reamed and new tubes installed, using ferrules if necessary to fill the excess clearance.

Seldom is it advisable to perform repairs to any part of a staybolt by welding, and often it may be dangerous. The most common place to see welding applied to a staybolt is in a bead around the calking edge of the staybolt head on the fire sheet of firebox boilers. This may be done to stop leakage past the threads and calking

Fig. 5—If leakage is caused by localized internal corrosion, attempting to weld calking edge may destroy holding power of remaining threads, and an explosion may follow. Fig. 6—If full load on a patch will be carried by stays or braces, the patch may be welded into place; check local regulations for size of patch



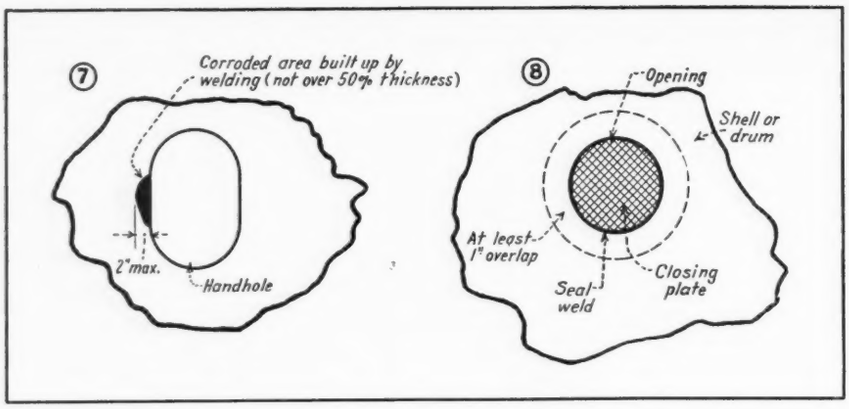


Fig. 7—Corroded area around handhole may be built up by welding, within certain prescribed limits. Fig. 8—An inside patch, seal welded, may be used to close an unneeded unreinforced opening

edge or to build up a burned-off head. Fig. 4 shows leaking staybolt heads; the left chalk circle marks a burned-off head, that on the right a staybolt indicated by hammer test as broken.

Fig. 5 shows why it may be exceedingly dangerous to weld the calking edge of leaky staybolts until a thorough investigation of the water surfaces shows no internal defect. Often localized corrosion leaves but one or two threads in contact, permitting leakage. When the arc heat hits the fire side, the thin plate may distort and practically destroy the holding power of the remaining threads. At boiler pressure, collapse of the furnace may produce a violent explosion.

Replacing a burned-off head by welding may present similar unsafe conditions. Once the head has been burned off, exposure of threads nearest the fire may result in overheating, distortion, and loss of holding strength. Welding on a new head is a surface operation that does little to restore lost strength.

External Corrosion

Deterioration of the fire side of boiler surfaces is not uncommon, especially in the presence of moisture. Sulphur in soot reacts with moisture to produce acids and consequent rapid eating away of metal. Repairs involving building up these areas may be advisable in many locations, if the extent of the area and loss of thickness are not excessive.

Welded Patches

All patches that are not fully stayed should be riveted. If a piece of plate becomes defective in an area where a replacement plate would have its full load carried by stays or braces, welding may be used to form the patch seams. The edges of the remaining shell and those of the patch are veed so that full penetration may be secured in the butt weld. Patch seams should come approximately midway between stays, Fig. 6. Many localities limit the length of such seams that may be welded to 36 in. If one seam of the welded patch is at the mud ring, the Pennsylvania Code limits the height of the patch to 12 in. and the horizontal distance to 20 in.

Corroded Plate

Welding may be used to build up plate wasted by moderate external corrosion; a common place is at edges of manhole openings. The Pennsylvania Code permits such reinforcement by beads of welding if the corrosion has not caused a reduction of over 50% in thickness and has not affected an area over 2 in. from the opening (Fig. 7). This same code limits to 40% the reduction of thickness in stayed sheets that may be repaired by the welding process.

Sometimes a change in operations will make unnecessary an unreinforced opening in shell or drum. Closing such openings may be safely handled by welding in a plate that overlaps the opening on the *inside*, by at least 1-in. all around (Fig. 8). The closing plate should be of same material and thickness as the shell to which welded.

Seal Welding

The method of welding described above is also known as "seal welding." This may be used on the calking edges of riveted seams where severe service conditions make them difficult to keep tight. Such welding should only be used after the seam has proved tight and safe under hydrostatic test and other necessary investigations. Fig. 9*A* shows a patch seam before seal welding; *B* shows the seam after welding. Seal welding should be neatly applied in a small bead.

These pointers show that while welding repairs are widely accepted, many such repairs are strictly taboo and positively dangerous. This serves to emphasize the importance of securing approval of a qualified boiler inspector, although preliminary decision as to method of repair may be made by following Pennsylvania Code Rule G-2: "Autogenous welding may be used in boiler repairs where the strain is carried by other construction which conforms to the Rules formulated by the Department, and where the safety of the structure is not dependent on the strength of the weld."

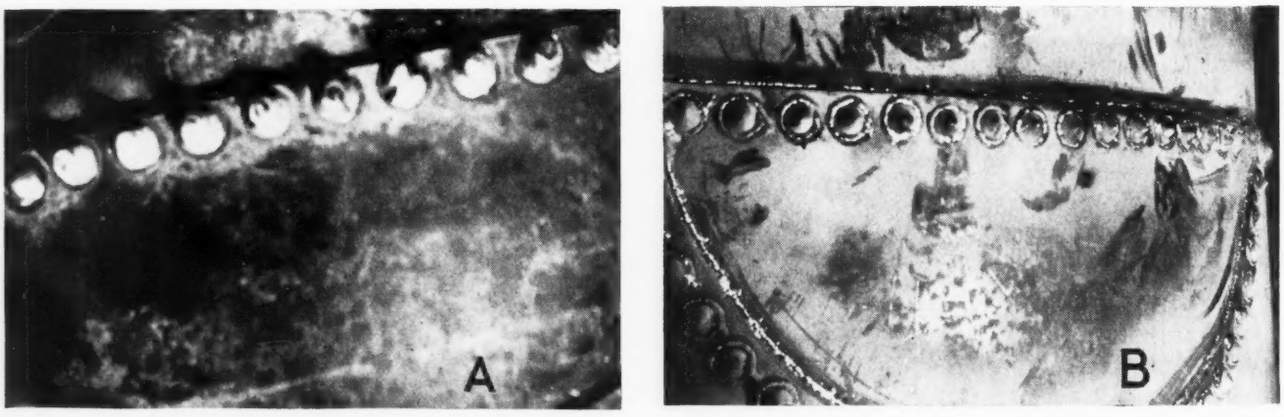
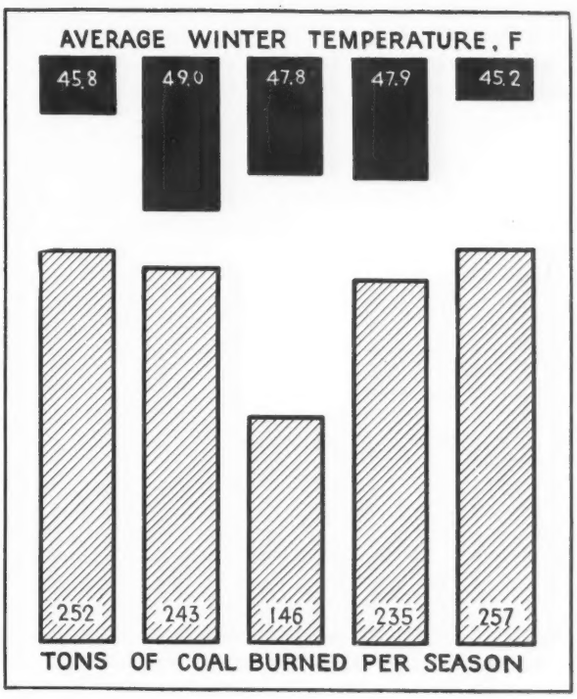


Fig. 9—(*A*) Patch seam before seal welding, (*B*) after welding

Simple Scheme Cuts Heating Costs

By JOHN F WOOLEY

Records for five successive heating seasons show effect of systematic operating plans and what happened when old hit-or-miss ways were resumed



OPERATION of heating equipment in small or medium-size buildings all too often falls on an employee, with numerous other duties, whose knowledge of combustion principles is too sketchy to distinguish between economical use of fuel and waste. Naturally, he stokes the furnaces when convenient and without special regard for firing efficiency. Usually without records of coal consumption or steam output, he cannot be blamed if building heating costs more than it should.

Automatic Control

The apparent alternative to such a condition is installation of some form of automatic control. This naturally, is highly desirable, but in most cases, in smaller buildings, the money for improvements of this kind is not forthcoming. Some form of scheduled operation, reduced to simplest terms, will fill the gap between no control and full automatic control, saving a large part of the waste with little or no investment. Here is what happened when we applied such a simple system.

To know the quantity of fuel used was the first problem—and it was a problem because the management didn't believe the cost of a suitable scale was justified. However, the argument that the mere saving of one shovel of coal a day would pay for the scale in one season finally rang the bell and the requisition was approved.

Careful records were kept of fuel consumption, for 100 consecutive days, to give changing conditions a chance to repeat themselves. Study of these figures and of average temperatures for the same period showed, for example, that during one day, when the average temperature was 54 F, 580 lb of coal had proved sufficient while on another day, with the same average temperature, 970 lb had been required. Of course, there were big discrepancies between actual fuel consumption and calculated consumption.

From the information in this record, it was possible to set up a schedule for each shift showing approximate fuel consumption for various outside temperatures. Thus, when an attendant began his shift, he first noted the outside temperature and then consulted the schedule. This gave an idea of the approximate fuel consumption and it was surprising how soon the men learned to notice any condition that caused a higher rate of consumption than the schedule called for, such as a few radiators that should have been turned off at midnight, failure to clean the boiler tubes on the preceding shift, or just bad firing.

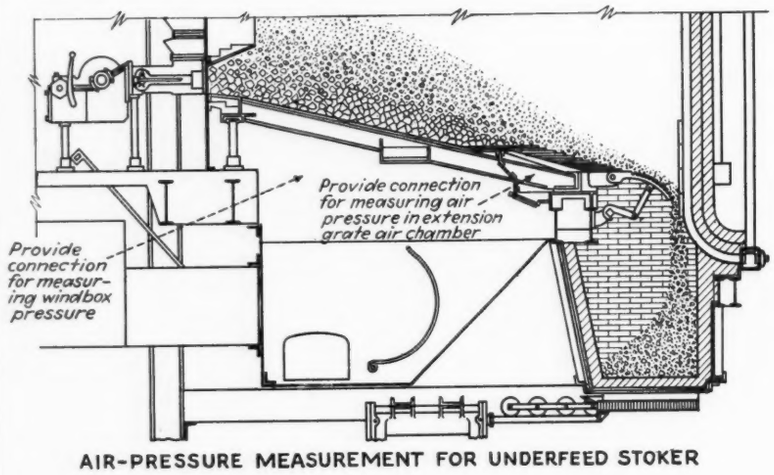
The reduction of fuel consumption produced by use of the schedule was so great that it cast doubt on the accuracy of the records. Every effort to discover any false or inaccurate entries failed, leaving undeniable proof that dramatic savings had been made.

By giving each employee with a part in the work a chance to visualize his own performance, this system created a new interest in the entire organization. Of a more practical nature, the records made it possible to measure the wasteful effect of excessive heating and its companion fault, needless ventilation, which account for a large part of the heating cost in the average building. It likewise checked what, in my opinion, constitutes the greatest loss: the careless and indifferent attitude toward the principles of combustion. All too often the fireman, janitor, porter, engineer, or whatever he may be titled, reflects the attitude of the building management that a certain amount of fuel is needed to heat a certain building without regard for the methods used to fire the fuel and apply the heat. A record such as provided by this simple system knocks any such idea in the head immediately.

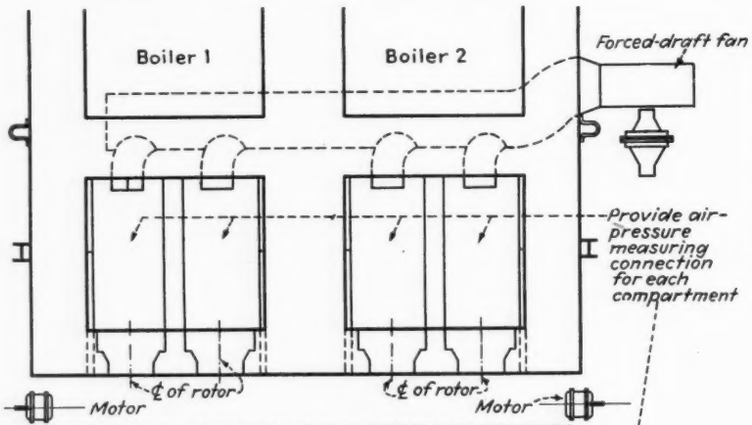
Record-Keeping Time

Some may criticize this scheme on the ground that too much time is required to keep the records. To prove the point, I wheeled out coal, weighed each wheelbarrow load, cleaned the fire and ashpit and stoked the fire as needed, and noted inside and outside temperatures, during one 8-hr shift. 56 minutes out of the eight hours doesn't seem too much for these activities. To those who criticize on the ground of crudeness, I say that when investment in equipment must be held to a minimum, this method offers savings as big as any other of equal simplicity and ease of application.

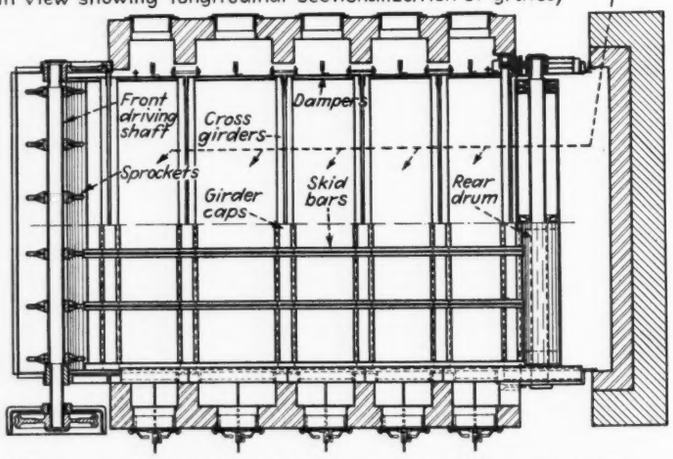
DRAFT GAGES
for Firing Equipment


Provide connection for measuring air pressure in extension grate air chamber
Provide connection for measuring windbox pressure

AIR-PRESSURE MEASUREMENT FOR UNDERFEED STOKER



AIR-PRESSURE MEASUREMENTS FOR SPREADER STOKERS
(Plan view showing longitudinal sectionalization of grates)



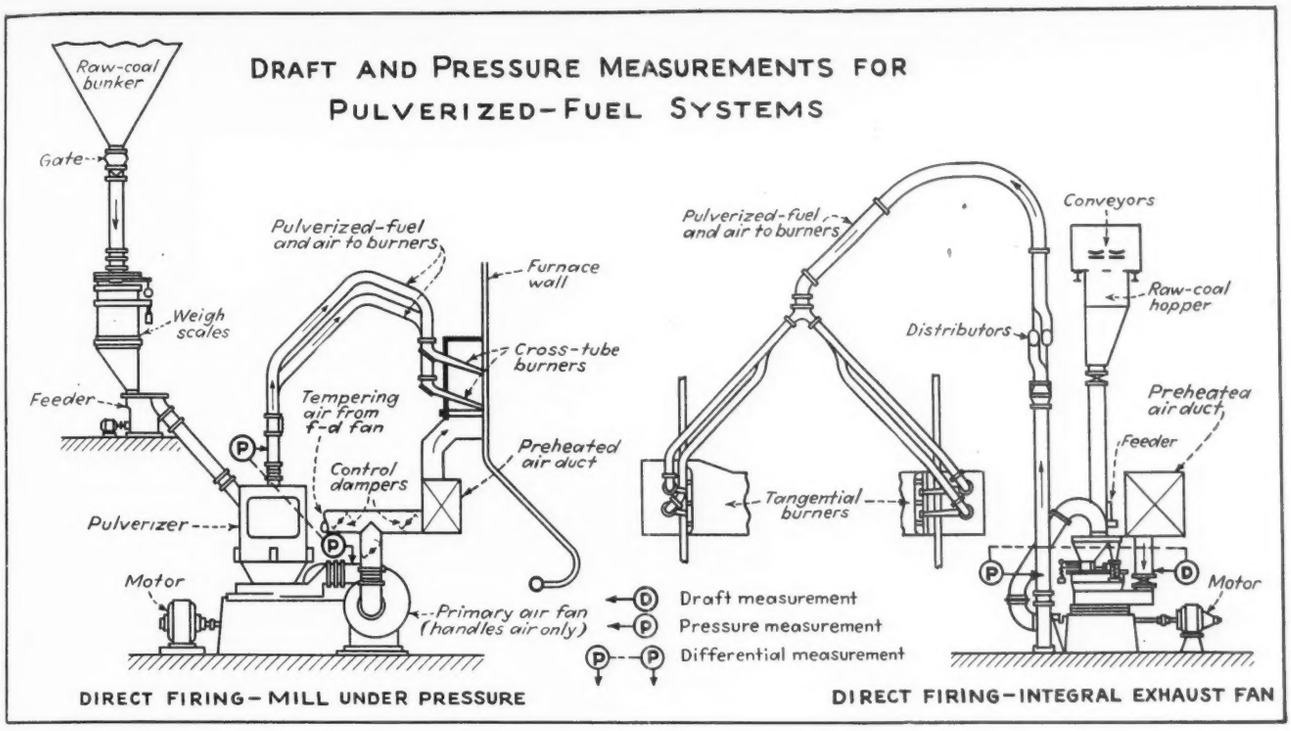
AIR-PRESSURE MEASUREMENTS FOR CHAIN-GRATE STOKERS
(Horizontal section showing crosswise air compartments)

Efficient combustion depends on knowing how much air is supplied and where it goes. W H Pugsley, The Hays Corp, tells how properly placed draft gages give the answers

▶ REGARDLESS OF THE KIND OF FUEL to be burned, natural-draft equipment needs no draft or pressure measurements; the "furnace-draft" indicator serves as a guide to the quantity of air being supplied for combustion. On the other hand, air-pressure indicators, on forced-draft equipment, give a rough indication of how much air is being supplied and where it is going. These approximate air-flow measurements serve as useful guides to the proper operation of the firing equipment and auxiliaries. The following summarizes briefly the points to remember in applying draft gages to different kinds of firing equipment.

Underfeed Stokers: Measurement of air pressure in the windbox roughly indicates rate of air flow through stoker and fuel bed. If resistance of grates and fuel stayed constant, air pressure would increase practically as the square of the burning rate. However, character of the fuel, its fineness, and its moisture condition all affect the fuel-bed density and so alter the relation between windbox pressure and load. Thus observation of windbox pressure gives a picture of changing fuel-bed conditions. Connection for the windbox measurement is generally made through the front plate of the stoker.

Most multiple-retort underfeeds have an extension grate at the tail of the stoker. This grate surface receives its air supply from the main windbox, usually under control of a manually oper-



ated damper. Control is important because the fuel bed at this point is thin and too-high pressure would mean high excess air and low CO_2. Too-low air pressure means insufficient air, and unburned coke going to the ashpit. Pressure of air supplied to the extension grate is much lower than windbox pressure and so requires greater care in control. Connection for measurement is usually made through the sidewall to the extension-grate air chamber.

Spreader Stoker: Lengthwise sectionalization provides a separate air supply for each grate section served by a single feeder mechanism. Hand-controlled dampers permit shutting off one section while ashes are being dumped. These dampers also proportion air supply to the zones after the ashes have been dumped, until all grates are clean and a uniform fuel-bed condition maintains. An indicator for each section enables the operator to gage conditions in each zone at any time. The small, relatively fixed amounts of overfire or spreader air do not justify separate indicators.

Chain- and Traveling-Grate Stokers: Manually operated dampers in compartments or zones extending across the grate give control of air supply as the fuel bed progresses from hopper gate to ashpit. Indicators showing air pressure in each compartment make it possible to regulate dampers intelligently. Connection is made to each zone through the stoker side plates.

In many cases, overfire air, from the stoker fan or a separate fan, enters the furnace through openings in the arch. A damper, usually manually controlled, regulates the amount of air supplied; a draft connection to the overfire-air duct permits operation of the damper by measurement rather than by guess. A similar hookup will prove helpful in regulating overfire air now sometimes supplied underfeed-stoker furnaces.

Pulverizers: Regardless of method of grinding, pulverizers depend on a flow of air to transport fuel to burners, or to bunkers if the bin system is used. Air may come to the mill under natural draft or under pressure. It is usually heated and cool tempering air is admitted to hold the temperature reasonably constant. The diagram above shows two common pulverizer arrangements, indicating how air is supplied and how the coal-air mixture is transported to the burners. Notice that in one case a primary-air fan forces air into the pulverizer and the coal-air mixture to the burners. In the second arrangement, the primary-air fan, called an "exhauster", sucks air into the mill and forces the coal-air mixture to the burners.

For satisfactory mill operation, it is desirable to measure draft or pressure at the entrance to the mill. Pressure measurements at mill or exhauster outlet give a rough indication of total mill output, providing a handy guide for operation. A differential measurement between air inlet and mill outlet indicates resistance to air flow in the mill. This, in turn, indicates quantity of coal in the mill, which, depending on the type of mill involved, bears a fairly close relationship to rate of operation and boiler load.

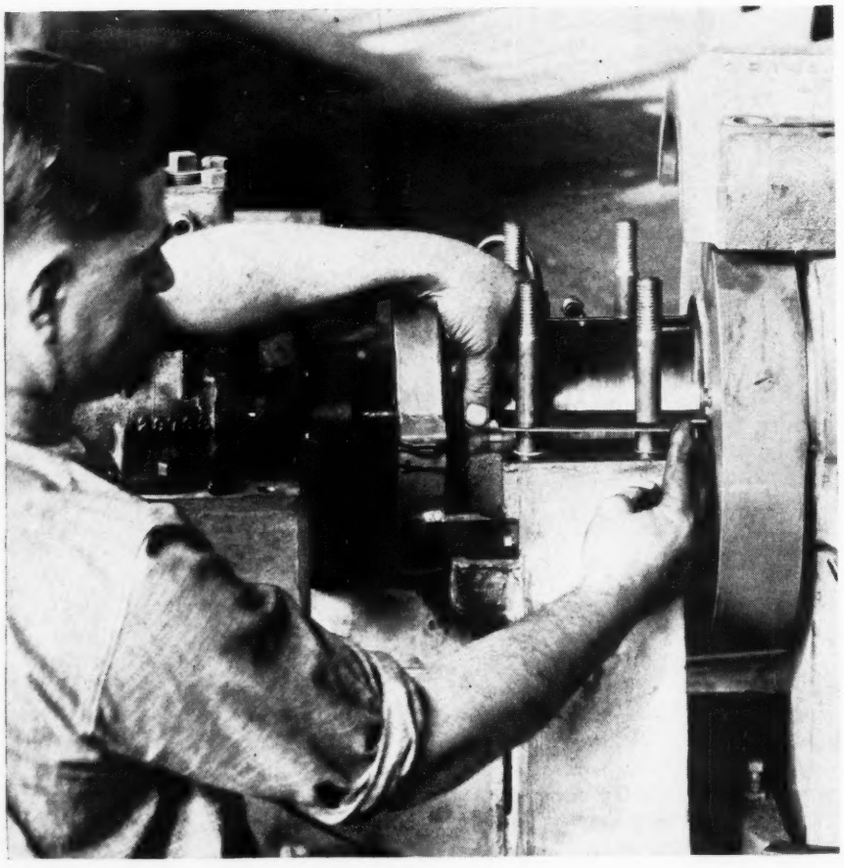
Pulverized-Fuel Burners: In any type of burner, measurement of primary-air pressure in the feedpipe indicates rate of flow of coal-air mixture to the burner. Measuring secondary-air pressure in the burner box of turbulent burners gives the information needed to vary air pressure with rating so that the proper relation between fuel and air is maintained. Likewise, measurement of tertiary-air pressure in straight-through burners permits adjusting pressure to changes in quantity of fuel burned. This air quantity is small compared with total combustion air but plays an important part in combustion efficiency.

Oil or Gas Burners: "Burner-box" pressure for oil or gas burners indicates total air passing through each burner, since the secondary air is, in this case, the total air. The importance of knowing the air pressure at each burner cannot be over-emphasized as it is essential to securing balanced burner operation when more than one burner is used.

Fuel pressure at the burner also constitutes a valuable measurement. Oil, at high pressure, requires a Bourdon measuring element but gas, at low pressure, can be readily measured by a gage of the draft type. Measuring differential pressure across an orifice in the gas line indicates the quantity of gas being burned.

Connections should be made to the front or side of the burner box so as to avoid the effect of burner-box-damper operation and air velocity.

PRACTICAL AIDS TO OPERATION



Close Adjustment of Pump Bearings

ON HIGH-PRESSURE, vertical power-reciprocating-pumps, the crankshaft bearings must be operated with very close clearance, to prevent pounding of the bearings and excessive bending stresses in the crankshaft. Provisions must also be made in these bearings so that their clearance can be readily adjusted to take up slight wear.

In one plant laminated shims are used under the bearing caps, see photo. These shims peel off in very thin uniform thicknesses so that bearing adjustments can be made quickly and easily. The take-up is uniform over the entire bearing length, insuring precision adjustment both in assembly and in subsequent servicing.—FIELD EDITOR.

Stack Inspection With Binoculars

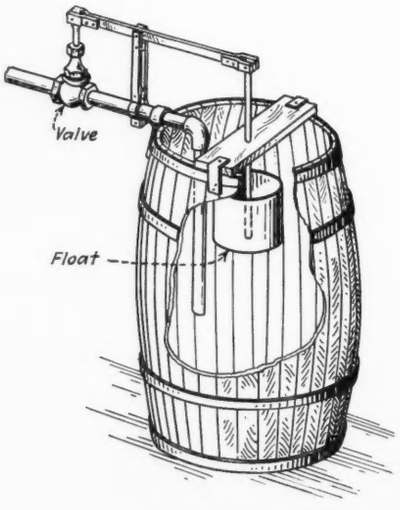
MASONRY STACKS, although representing a sizable part of the total investment in boiler plants, frequently do not receive the attention they should. In some case this is due to a lack of a proper understanding of the factors, such as the weather, fly ash, abrasion, corrosion of lightning-protection equipment, etc, that attack a stack, particularly at its top. Even when these things are understood the top of a high stack is not the pleasantest place to make an inspection, and operators are frequently reluctant to take the risk of doing this job.

In one large plant the operators have a pair of powerful binoculars for making regular monthly or more frequent inspections of the stack. After a little practice with the binoculars the inspectors become familiar with general conditions at the top and upper parts of the stack and can readily detect anything unusual if it develops on the outside.

In this plant the regular operators are not permitted to climb the stack. Every two years, or more frequently if found necessary, specialists are called in to give the stack a careful inspection and do any necessary maintenance. Between these inspections the plant personnel make their regular inspections with the binoculars and maintain the stack, from the breeching connections down.

One of the important parts of this work is to see that the lightning-rod connections into the ground are not impaired in any way. If the resistance of these connections to ground is not kept low the effectiveness of the rods is greatly reduced and the stack may be seriously damaged by lightning.

Richmond, Va. C R ANDERSON



Homemade Automatic Float-Valve Control

AFTER BEING GIVEN THE JOB to operate a portable boiler I found that the feedwater came into a barrel from where it was taken and put into the boiler by an ejector. A hand-operated globe valve controlled water flow into the barrel, but apparently it had been frequently forgotten and the water let flow because of the mud hole around the boiler. I decided to make an automatic float control for the valve.

To do this I removed the valve stem and filed off the threads so that it could move up and down freely through the

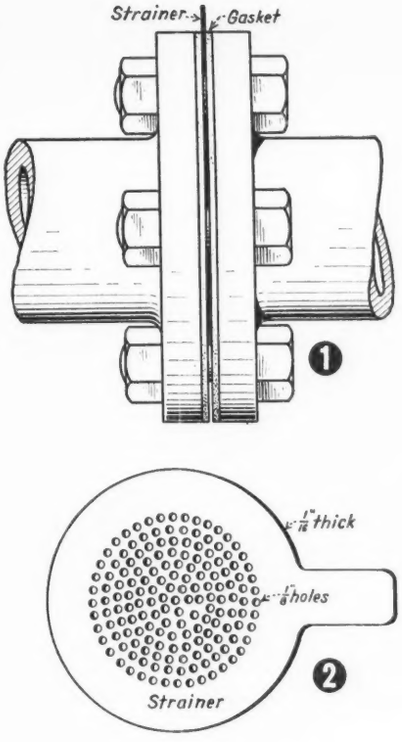
packing. Then I attached a float operated lever as in the figure. The float was made from a 1-gal tin can attached to the bottom of the float rod. I also turned the end of the inlet pipe down into the barrel so that water would not get into the float. This simple arrangement satisfactorily controlled the flow and also insured water being in the barrel at all times for the boiler.

Riverdale, N. Y. ALEX GRAY
Chief Engineer, Colored Orphan Asylum

Metal-Disk Strainer Protects Pump

ON A TEMPORARY PUMPING JOB where the water might carry almost anything, a strainer was not available for the suction line. As the pump was of the rotary type we did not wish to take a chance of letting hard objects get into it. To solve the problem we cut a round, thin metal disk that would fit inside the suction flange bolts and bored the disk full of ⅛-in. holes, Fig. 2.

This disk we put into the suction flange between two gaskets, as in Fig. 1. When the pumping job was completed the bottom of the suction pipe was found partly filled with pebbles, rust, sticks and other debris. If this material had gone into the pump it would have caused serious damage.



New York, N. Y. S M ELONKA

Water Cracks Journal-Bearing Surface

A STRANGE CASE of surface cracks in steel developed in the crankshaft of a vertical engine. One of the main bearings on this shaft gave trouble from overheating and was kept cool by playing water against the end of the shaft. Eventually it was decided to replace the bearing.

To make sure that the journal was in good condition the crankshaft was put into a lathe and a very light cut taken off the journal. When this was done hundreds of fine hair cracks about 2 in. long were found in the surface of the journal, running parallel with the shaft. These cracks undoubtedly were caused by sudden cooling of the journal with water after the metal showed signs of overheating.

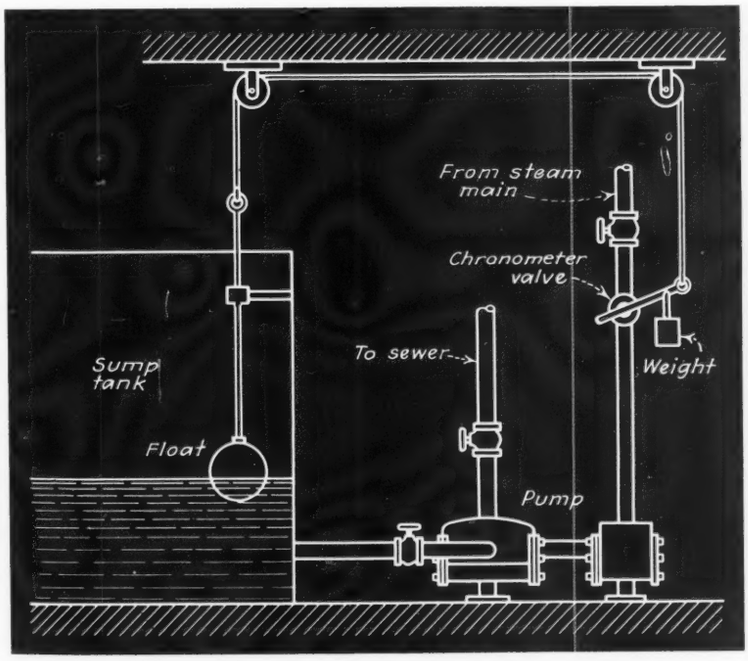
Coventry, England F L BERRY

Simple Control Improves Sump-Pump Operation

OUR STEAM-DRIVEN RECIPROCATING SUMP PUMPS are in a pit on about the same level as the bottom of the sump tank. These pumps had a complicated control system that started them when the sump tank was nearly full and stopped them when it was nearly empty.

This control got into bad condition and required an expensive repair. It also had the disadvantage that the tank had to be nearly full before the sump pumps would start. Sometimes the tank, filled near the pump-starting point on the control, would receive a heavy flood of water from the laundry that the pump could not handle and the tank would overflow.

When considering a solution of this problem we decided to make a control that would keep the pump operating as long as water in the tank was above the minimum level. This proved to be a very simple job, as shown in the diagram. A chronometer-type plug valve was installed in the steam line to the two pumps. To the free end of the weighted operating lever on this valve we connected the float rod, by a small rope running through pulleys.



With this arrangement the pump operates practically continuously, slowing down as the tank empties and speeding up as it fills up. Operating the pump at slow speed as the tank empties permits pumping to a considerably lower level without danger of drawing air into the pump.

This control has overcome all our difficulties and the cost of its installation was only about one-tenth of what it would have cost to repair the old one. The pumps are now controlled the way we want them, something impossible with the old control.

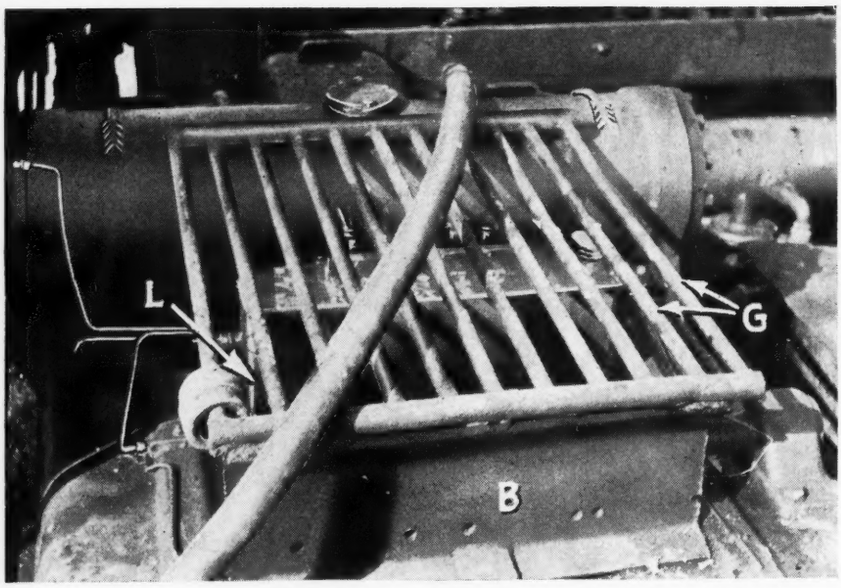
New York, N. Y. THOMAS WOOD
Chief Engineer, Hotel Commodore

Reel Takes up Lamp-Cord Slack

LONG EXTENSION CORDS for lamps are always a tangled mess on the job and frequently get in the way of workmen. We decided that something should be done to correct this condition and the illustrations show the results of our brain storm. Through one end of a wooden reel, large enough on which to wind the lamp cord, we cut a hole and fixed in it the socket of an attachment plug. The cord is wound on the reel and the plug end looped under the last turn, as in Fig. 1.

A handle on the end of the reel permits it to be carried to the job. When the cord is to be used, the necessary length is unwound off and the free end is plugged into the power outlet. The reel is then placed near the work and the extension lamp plugged into the socket on the reel, as in Fig. 2. If more than one lamp is to be connected to the reel a multiple attachment fitting is first plugged in the reel attachment plug and the lamps connected to this fitting. Maintenance men will appreciate the advantage of this scheme, both when the cord must be carried from one place to another and when actually using the cord on the job.

Boston, Mass. B R STEWART

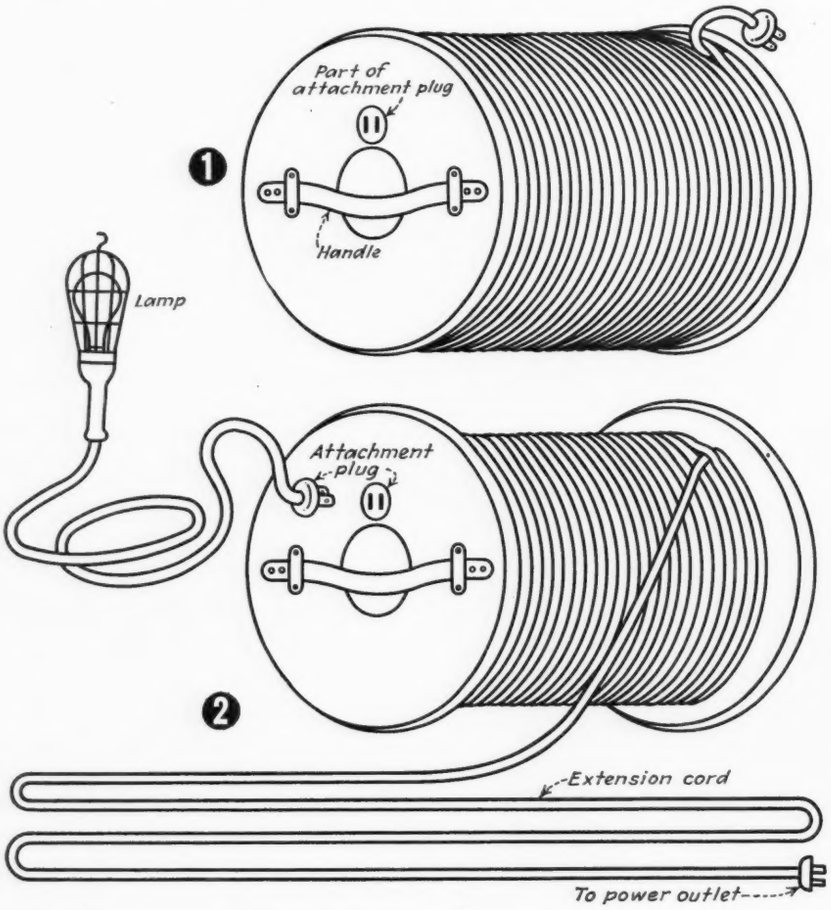


Grille Protects Pump Lubricator

LOCATION OF THE LUBRICATOR *L* on the frame of a high-pressure power-driven pump, as in the photo, permitted the oil leads to be a minimum length, but exposed the lubricator to possible damage by falling objects or other causes. To provide the necessary protection we bolted a short section of 8-in. I-beam *B* to the pump frame. On top of this we tack-welded one end of a grille *G* which spans the lubricator to be supported on the housing over the drive shaft.

The bars of the grille made of pipe are spaced widely enough to permit inspection of the sight feeds, and serve to support a funnel when the unit is being filled. The guard can be quickly removed by taking out the cap screw connecting the lower flange of the I-beam to the pump housing.

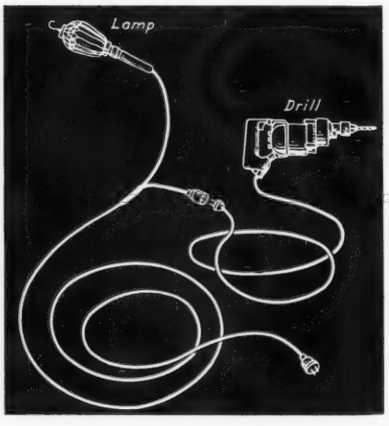
Houston, Texas M T PATE

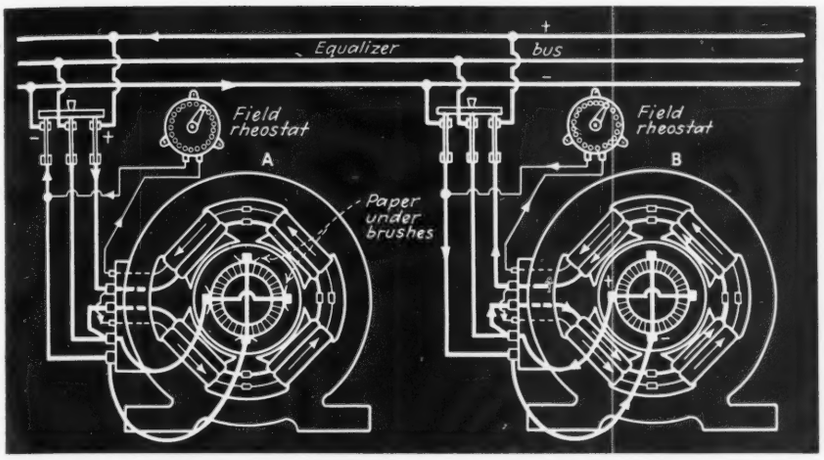


Lamp Extension Cord Made More Useful

ONE OF THE HANDIEST KINKS in our plant is the extra socket, shown in the diagram, connected into our extension lamp cords. The socket, a standard weatherproof type, has an ordinary attachment plug screwed into it for plugging in another extension cord connection.

Englewood, N. J. R BOETTINGER





Reverse Polarity on DC Generator Cured

When starting up a new direct-current generator that was to run in parallel with another machine already in operation, I found the polarity of the new machine opposite to that of the other one. To correct this condition I shut down the new machine and turned the field rheostat to cut all its resistance into circuit. Then I lifted the brushes in each group off the commutator and put a sheet of thick paper under them and made sure that carbon dust or other dirt did not make contact between the brushes and the commutator. This opened the armature circuit.

Then I closed the main switch and turned the field rheostat to cut all resistance out of the field-coil circuit, which applied full voltage across the field coils, as on machine *A* in the figure. Full current was then flowing through the field coils in a direction to give the polepieces correct polarity.

After a few seconds I turned the rheostat back to put all resistance in the field-coil circuit and then opened the generator switch. When the brushes were put back on the commutator the generator had correct polarity to be connected in parallel with the other machine. Make sure that the brushes do not touch the commutator at any point or the commutator may be burned.

Plainfield, N. J. H W Hodgson

Pump Capacities at High Temperatures

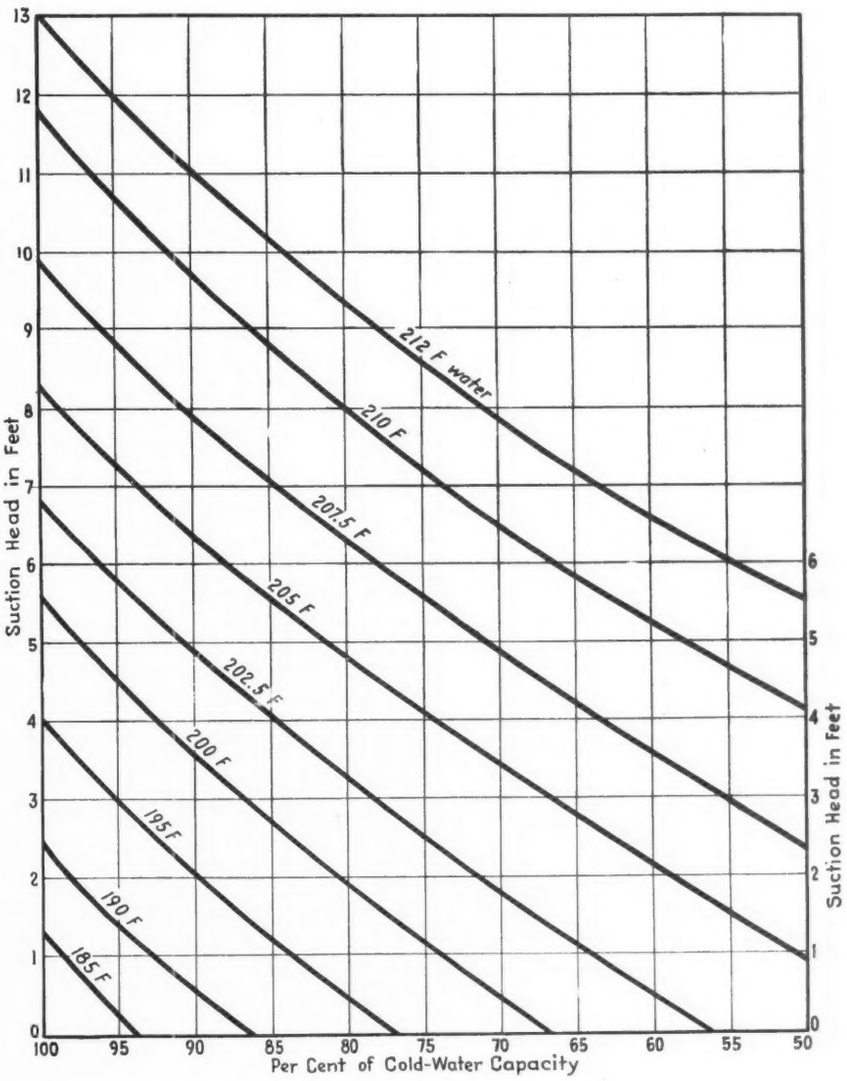
When planning the installation of a centrifugal pump for handling hot water, it is fully as important to analyze properly conditions prevailing at the site of installation as it is to select the proper rating for the pump. If hot water is to be handled, place the pump far enough below the source of supply to give sufficient positive head on its suction to keep the water from flashing into vapor.

If positive head on the suction is not high enough, pump capacity will be reduced, or, in extreme cases, the pump will even fail to operate. The curves shown indicate the approximate reduction in pump capacity that may be expected when handling water at various temperatures with different positive heads on the pump suction.

From these curves it is seen that if the water is at a temperature of 210 F, the positive suction head should be at least 12 ft, in addition to that required to take care of the friction in the suction line. If it is not possible to obtain more than 6 ft suction head at the pump, it would operate only at about 66% of its cold-water rating.

For these conditions, it is therefore advisable to select a pump with a cold-water rating approximately 50% greater than required, in order to insure having sufficient capacity when pumping 210-F water. Thus, if a pump is needed to deliver 100 gpm of 210-F water, it would be necessary to choose one that has a catalog rating of 150 gpm cold water. This pump would deliver $150 \times 0.66 = 99$ gpm at 210 F when operating with 6-ft positive head on its suction. Also use suction piping about two sizes larger than the pump suction and an eccentric reducer between the suction line and the pump.

New York, N. Y. Frank A Kristal



READERS' PROBLEMS

Questions from Our Readers

Will Pipe Cleaning Pay?

Question 1

IN OUR WATER PLANT, *we have two deep-wells equipped to pump into an 8-in. line 2850 ft long, with a 6-in. line from each well pump, 320 ft long. The sketch shows the general arrangement. These lines are scaled up badly, especially the 8-in.; it has an area about equal to that of a 5¼-in. pipe. The question is, will there be a pay-out if we spend approximately $700 cleaning these lines, and how long will it take?*

Under present operation, which is fully automatic, No. 1 pump starts and pumps at a rate of 230 gpm for the first hour, then runs for about 48 hours at 208 gpm and if continued in service for several days without stopping drops down to about 200 gpm and stays there for 6 or 7 days' run. The total head is 268 ft. When No. 1 pump drops under 228 gpm, No. 2 comes on until water level in the filters reaches a predetermined level, and then shuts down. If the booster should run out of water at the clear well, it stops and when the deep-well pumps fill the clear well, the booster starts. Should the storage tank, 7¼ miles away, fill, the booster stops.

When pumping alone, at 220 gpm, No. 1 pump uses 22 hp, and when No. 2 is running the total input is 34 hp. Our electric power rate is based on a guaranteed load of 100 hp and the energy charge is $.012 per kwhr. At this time of the year, No. 1 pump furnishes all the water we need and from the end of March to the middle of October, No. 2 pump cuts in for about 25% of the time, on the average.—FTW

Returning Condensate

Question 2

IN A RECENT EXAMINATION, *this question was asked: "A dry room is quite a bit lower than the boiler room of a laundry plant. How can the condensate be returned to the boiler with the use of only one trap, set correctly on the boiler setting. In other words, the condensate from the dry-room coils has to reach the trap on the boiler without help of other traps or a pump." Perhaps readers of* POWER *can give some suggestions as to a hookup for these conditions.*—NTG

More Hp from Steam Engine

Answers to Dec Question 1

The Question

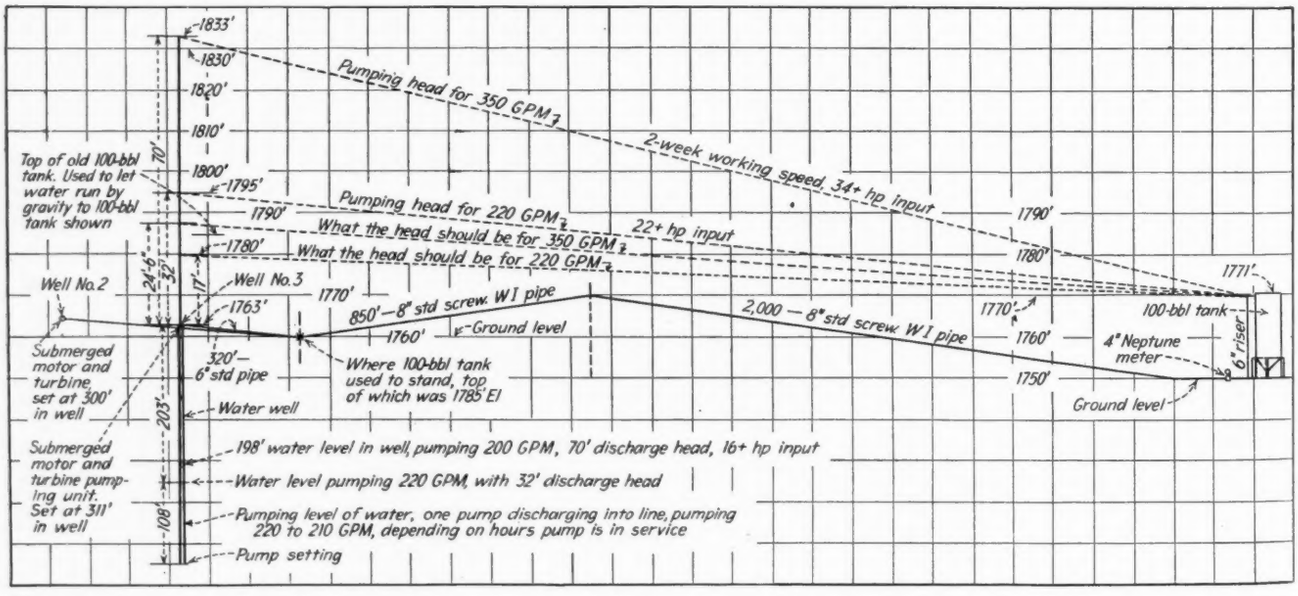
WE HAVE *a Ball & Wood tandem-compound, 4-valve engine direct-connected to a 200-rpm, 200-kva, 440-volt, 3-phase generator. The high-pressure piston is 17$\frac{11}{32}$ in. diameter, the low-pressure piston is 34$\frac{17}{64}$ in., and the stroke is 18 in. The engine is about 35 years old but in good condition. This unit has a center crank with outboard bearing. A wheel governor controls steam valves on both cylinders, through a single rod, and a single eccentric (adjustable by hand) operates exhaust valves on both cylinders. At 115 lb throttle and 8 lb back-pressure the engine develops about 102 hp. How can we increase the output?*

The early cut-off in the low-pressure cylinder causes the expansion line to go below receiver pressure and the backpressure causes compression to be too high, so that this cylinder develops practically no useful hp. The construction of the engine is such that it is impossible to add a third eccentric and rocker arms to handle the low-pressure steam valves. It has been suggested that we equip the engine with a throttling governor and set the present wheel governor at a predetermined cut-off point. Economy is no object, and the existing regulator can take care of voltage—RMD

Make Low-Pressure Cylinder Smaller

A STUDY OF THEORETICAL INDICATOR CARDS drawn from RMD's data reveals a number of interesting things. In the first place, assuming the engine is adjusted for maximum of ⅝ cutoff, and working at 115 lb gage initial pressure and 8 lb backpressure, computations from the theoretical cards show considerably more output than 102 hp. Based on a present mep of 65 lb for the high-pressure cylinder and 4.7 lb for the low-pressure cylinder, the respective indicated horsepowers will be 270 and 80, adding up to 350 ihp. If the engine is operating with maximum cutoff and still only producing 102 hp, the problem can be considered from another angle.

Based on the same assumptions, the ratio of cylinder capacities is 34.266^2 divided by 17.343^2 or 4:1 and the minimum number of expansions is 1 divided by 0.625 times 4, or 6.4. Neglecting clearance and heat losses, pv equals a constant and the terminal pressure is 130 divided by 6.4, which equals 20 lb abs. This is 3 lb lower than the actual backpressure. This is for maximum cutoff and if this is shortened the terminal pressure will be even lower, so one remedy for negative loops at extremes of the card is to make the low-pressure cylinder smaller in diameter. Then



ratio of expansion will be lower and more useful work will be accomplished in the low-pressure cylinder, see sketch at lower right-hand corner of this page.

The theoretical card indicates this smaller diameter should be about 2 in. as this is the point at which the terminal pressure is the desired 8 lb g. It would seem that a great part of RMD's trouble lies in the fact that this engine was originally designed to operate condensing, taking advantage of the maximum number of expansions.

Galt, Ontario H PARKINSON

Reset Exhaust Valves

IT IS RATHER DIFFICULT to answer RMD because of lack of information and what seems to me to be an error in statement. An indicator card from both high- and low-pressure cylinders and data on the receiver pressure carried would help considerably. RMD states that the early cutoff in the low-pressure cylinder causes the expansion line to go below the receiver pressure. The expansion line is always below the receiver pressure; did he mean high-pressure cylinder, or atmospheric pressure?

A constructed indicator card from the high-pressure cylinder shows a very early cutoff and if the governor is "riding high" enough to give an early cutoff in the high-pressure cylinder it will naturally give an early cutoff in the low-pressure cylinder. According to the information given, it will require an mep of 21 lb to produce 102 hp in the high-pressure cylinder, no work being done in the low-pressure. This means a cutoff of less than $\frac{1}{8}$ stroke, which is extremely early. It seems to me that the best way to make this engine do more work is just to give it more to do.

To reduce compression in the low-pressure cylinder, it will be necessary to reset the exhaust valves with less positive lap. The question of too-early an opening comes into consideration here and RMD must use his judgment in this matter. I question if anyone can tell him just how much. To obtain less positive lap RMD may have to re-cut the keyways on the valve stems. Again his judgment has to tell him just what to do. A suggestion as to the angle of approach to the problem is all that can be offered from a long-range position.

Waterbury, Conn. F W CARTER

Cut the Backpressure

THE FIRST THOUGHT occurring to one looking over RMD's question is "if economy is no object then why not eliminate the backpressure?" Immediately one thinks of condensing equipment, but that may not suit the plant nor the engine design. However, if this 8-lb backpressure is on a process system, I would suggest he supply this system from the mains through a reducing valve and allow the engine to exhaust to atmospheric pressure. This would simply mean an exhaust-line piping change.

The following figures show that this change would give full engine power. As stated at present, the low-pressure cylinder is doing no useful work and the high-pressure cylinder is producing 102 hp. To produce full power, an engine of these dimensions must have an mep of 38.2 lb per sq in. To balance the engine load and develop 100 kva, the high-pressure cylinder will require an mep of 31.2 lb and the low-pressure cylinder an mep of 8.06 lb. From this it can be seen that removing the backpressure will produce the desired result.

Kearny, N. J. GEORGE MCNALLY

Put Line in Low-Pressure Cylinder

I INFER FROM THE WORDING of the question that RMD is using the exhaust on a process or heating load and from the generator and cylinder sizes that the engine was designed to operate condensing, and probably has been rebored. Assuming this to be the case, the engine was originally 17x34x18 and it then conforms to the maker's size for a unit taking steam at 125-135-lb g and operating condensing, the cylinder ratio being 1:4. The average ratio of cylinder capacities for 4-valve engines operating with 115 lb throttle pressure is 1:2.5 but as RMD is operating at 8 lb backpressure, the ratio should be 1:2.4. With high-pressure cylinder at 17.265 in., low-pressure cylinder should be 26.315 in.

I suggest that the low-pressure cylinder be fitted with a liner and a new piston, the liner being 26.3125 in. ID and extending as close as possible to the heads. Valve ports should be cut through the end in such a manner as to give full port area but leaving no unnecessary space to increase the clearance volume. At normal full load, operating non-condensing, the high-pressure cylinder cutoff should take place at about 40% of the stroke and with the smaller low-pressure cylinder this will be enough steam to maintain 40-45 lb receiver pressure and slightly over 8 lb in the cylinder when the exhaust valve opens.

I know of no way to adjust the valve gear to make the engine operate more satisfactorily under present conditions and a throttling governor will give little more if any steam as the cutoff on the high-pressure cylinder cannot be increased to over 50% of the stroke and as the low-pressure cylinder cut-off will be lengthened at the same time it will tend to again lower receiver pressure. The correct cylinder size for the operating conditions and

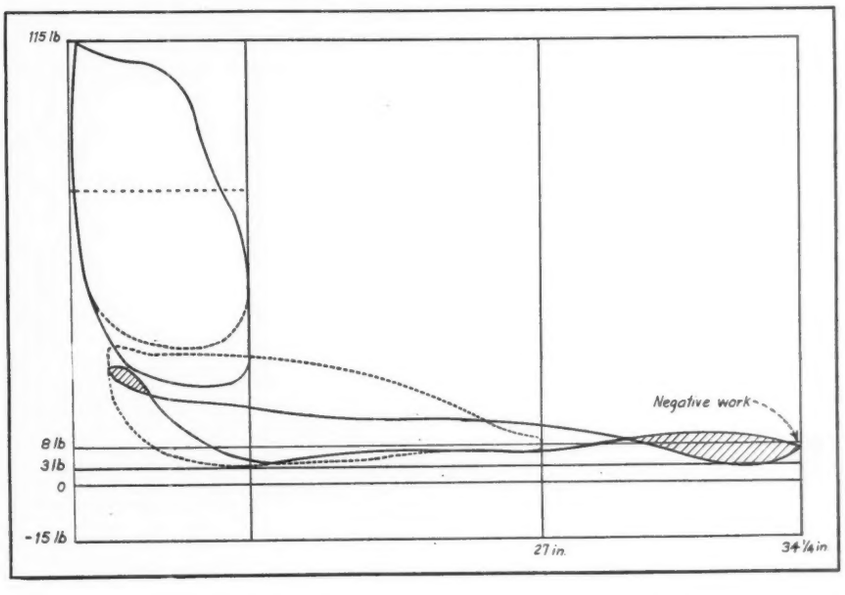
(*Continued on next page*)

Check Valve Setting

FROM RMD'S DESCRIPTION of his engine it appears that some experimental valve setting might result in obtaining more power, as no mention is made of how the indicated horsepower, when using various valve settings, compares with the engine's rated power. The case recalls a somewhat similar experience with a Ball & Wood compound engine which upon being re-assembled after an extensive overhaul ran so smoothly that it seemed an excellent job of valve setting had been done. However, the engine would not carry its rated load. When an indicator was applied it showed that the valve setting was so far out that the low-pressure side of the engine was doing practically no work, despite the apparent smooth-running quality of the engine. Proper valve adjustment restored the engine to its usual rating.

When valves are properly set to obtain best possible steam distribution and the governor is acting properly on both cylinders, it is obvious that the engine will be producing its highest possible power output under the existing conditions, and any additional power could scarcely be expected. It is doubtful whether the adoption of another type of governor could result in such an improvement unless complete redesigning of the valve gear and governor mechanism was resorted to, which seems out of the question. Therefore, it appears that the only remaining means of obtaining more power from the engine would be to increase the initial pressure supplied to it and to reduce the backpressure.

Jersey City, N. J. I S CHAMBERLAIN



the correct receiver pressure are what give the compound engine added power over a simple engine of the same size. Given the correct cylinder ratios for the operating conditions and any of the usual valve gears built on 4-valve compound engines can be adjusted to give correct receiver pressure and generally satisfactory operation if economy is not considered.

Houston, Texas H E FLOWERS

Make Simple Engine

THE MAIN OBJECT in compounding an engine, whether in cross or in tandem, is to gain the economy of multiple expansion. Since economy is not a problem in RMD's case, the solution is comparatively simple. He should make a simple engine of the tandem compound by idling the high-pressure cylinder and forcing the low-pressure cylinder to carry the load. This can be done by removing the piston from the high-pressure cylinder and either removing the valves from this cylinder or blocking them with ports open. This will decompound the engine to low-pressure cylinder operation.

Since the low-pressure cylinder will not withstand 115 lb and be safe, boiler pressure should be reduced, or a reducing valve installed in the line ahead of the throttle valve. Makers of the engine should be consulted about the safe working pressure of the low-pressure cylinder. However, if this can't be done, it is well to remember that a 34-in. cylinder will stand exactly one-half the pressure of a 17-in. cylinder of the same wall thickness.

Marissa, Ill. GEORGE BLUM

Too Much Backpressure

IF THE CYLINDER DIMENSIONS have been correctly given, RMD's engine surely was not designed for the conditions under which it now has to operate. With a piston-area ratio of nearly 4:1 it was probably intended to take steam at 150- to 175-lb g, have a full load cut-off of 25% and exhaust into a condenser or into a vacuum heating system. But, even so, it should develop more than 102 hp if it operates alone, unless the governor is all out of adjustment.

As the load is put on, the governor should increase the cut-off and the quantity of steam taken until the limit is reached where either the generator is overloaded or the engine starts to knock and then slow down. With an mep of 41 lb in the high-pressure cylinder and an mep of 10.5 lb in the low-pressure, each should develop about 175 ihp, sufficient to drive the generator at its full load of 200 kva. Instead, he says it develops only 102 hp which is assumed to be shaft horsepower, determined by noting the output of the generator. It is a long time since I have seen one of those Ball & Wood governors but, as I remember them, there are three separate adjustments, and unless thoroughly understood are not to be experimented with.

Probably the engine develops only 102 hp when RMD attempts to operate it in parallel with other units because the characteristics of its governor differ from those of the other governors. With two or more units operating in parallel, you cannot divide load between them by adjusting the field rheostats as with dc units. This only affects the power-factor. Instead, it is done by setting one unit to run at synchronous speed and adjusting the other governors so as to make the units take steam in proportion to the load each is expected to carry.

Also, on units regularly operated in parallel, each governor has a motor built into it which is controlled from the switchboard and which increases or decreases the tension on the governor springs as required while the unit is running. Since his governor is not provided with such a motor and is probably set for a no-load speed of 200 rpm he cannot get more than 102 hp out of the engine. He could, were it not for the 8 lb backpressure, but of that, more is said below.

If this unit is always operated in parallel with other units, he might try adjusting the governor for a no-load speed of 202 or 203 rpm and he will probably find that when he puts it on the bus with the other units it will take more load. He will have to bring it up to speed and synchronize it at part throttle and after it is on the bus open the throttle wider. If it then takes too much load he can readjust for a slightly lower speed or, if it doesn't take enough, he can give it a few more rpm. However, it is not advisable to go beyond 210, (a 5% increase) for should the other units drop their load or be taken off the bus first, this one would immediately speed up, with a resulting increase in frequency and voltage. Even if this is not objectionable, we do not know how many revolutions the flywheel will stand, although probably it is good for 300.

Or, he could install a bypass to bleed a moderate amount of 115-lb steam direct to the receiver between the high- and low-pressure cylinders. This would overcome the bad effect of the 8-lb backpressure and increase the output of the low-pressure cylinder. It would also decrease the output of the high-pressure cylinder; but the net result would be increased output of the engine as a whole. This step is not recommended unless a throttling governor is installed in the bypass, as it might result in a no-load speed that the regular governor could not control.

A relief valve should be installed to limit the receiver pressure to 50 lb or less. A pressure gage here would be useful though not absolutely necessary. Also, the bypass should be shut off first when shutting the engine down and it should never be opened until after the engine is running and the unit is on the bus.

If economy and expense really do not matter, piping the exhaust directly to atmosphere is recommended. This will be rather expensive because of the large piping, fittings, and exhaust head required, but it will get rid of the backpressure which is mainly responsible for the poor performance of the engine.

San Diego, Calif. C A LEQUESNE

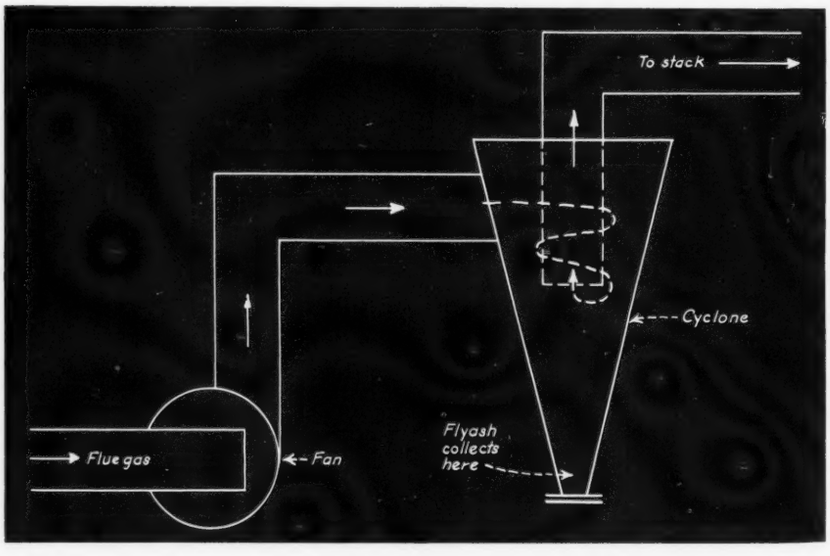
Pressure Differential

ACCORDING TO RMD'S INFORMATION, it appears that the engine was designed for greater differential pressure than exists with 115 lb at the throttle and 8 lb backpressure. If this is the case, RMD should increase the throttle pressure, reduce the backpressure, or both.

If throttle pressure is increased, receiver pressure will also increase and it is possible to reach a point where the receiver pressure will equal the compression pressure of the low-pressure cylinder, eliminating the excessive compression on this cylinder. Having a higher admission pressure for the low-pressure cylinder will cause the expansion curve to be proportionately above the present curve, thus eliminating over-expansion now obtaining.

If it is possible to reduce backpressure to a point below the lowest point of the low-pressure-cylinder expansion curve, this will eliminate the over-expansion and reduce the over-compression proportionately. If these suggested pressure changes cannot be effected in sufficient amounts, RMD may be able to increase throttle pressure slightly and reduce backpressure so as to give the required greater differential pressure.

Tonawanda, N. Y. W H BRITT

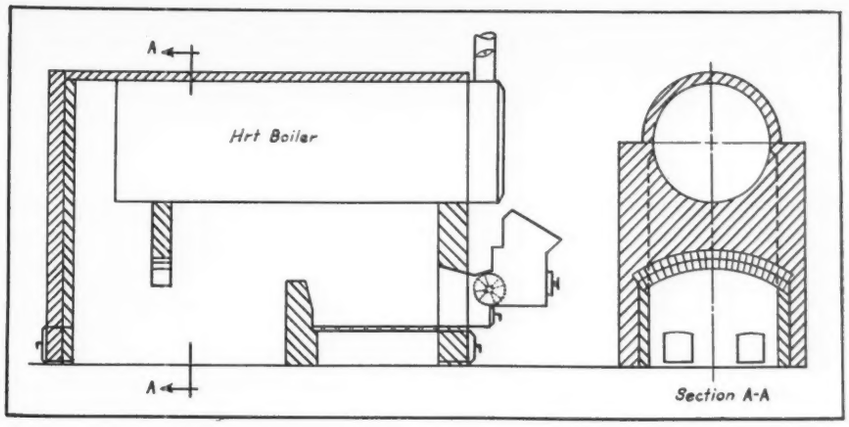


How Reduce Flyash?

Answers to Dec Question 2

The Question

CAN POWER READERS *pass along some simple, practical method of reducing flyash when using spreader stokers under water-tube and hrt boilers? Our units are reasonably high set and have sufficient combustion volume. The boilers are equipped with combustion control and draft under and over the fire has been reduced to a minimum.*—KB



Install Cyclone

KB SHOULD KNOW that, to maintain high efficiency as far as combustion is concerned, a rather high air velocity is necessary; therefore, some flyash is sure to be mixed with the flue gas. Flyash coming from the stack is a nuisance and to remedy this KB should install an inexpensive cyclone. A competent welder can construct a cyclone in a day or so, and in most cases where an induced-draft fan is used, the cyclone is easily installed, see sketch at left.

Parr, S. C. V C SUMNER

Several Solutions

KB'S QUESTION does not contain sufficient information to offer a specific remedy. Data necessary for properly analyzing the problem include: the type of feeder, whether overthrow or underthrow; the type of coal burned, whether anthracite, bituminous, or lignites; the fuel sizing, such as slack or nut-and-slack; the ash and moisture content of the fuel; the type of boilers and the baffling arrangement; setting height; grate area; burning rate; approximate furnace volume; and heat release. Hence only suggestions applying in general to the question can be offered.

Spreader stokers installed under hrt boilers are usually provided with ample horizontal space for flame travel and conservative firing rates and heat releases. The gas, passing over the fuel bed at right angles to it, tends to deposit the flyash behind the bridgewall, where it burns out and can be removed at intervals.

Setting heights not less than 8 ft from floor to shell, heat releases from 20,000 to 30,000 Btu per hr per cu ft, and combustion rates from 20 to 30 lb per sq ft of grate surface per hr, generally prove satisfactory when operated with from —0.05 to —0.10 in. furnace draft and +0.75 to +1.25 in. forced-draft, unless the coal contains an excessive amount of fine material (—20 mesh) and/or is high in ash content. When high moisture content or excessive fines, or both, are encountered, the installation of a sprung arch (see sketch) behind the bridgewall will precipitate a large part of the flyash. Free gas-passage area under the arch should not be less than that over the bridgewall.

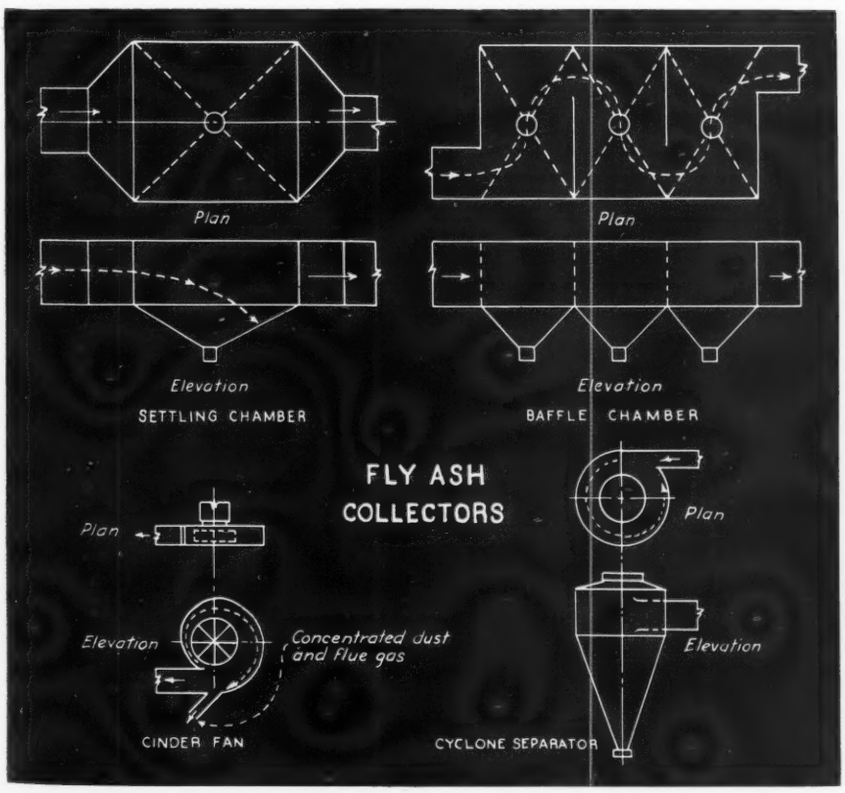
Water-tube boilers, particularly those vertically baffled, require careful study as to proper furnace design, heat release, combustion rates, and use of overfire air to reduce smoke and flyash emission from the stack. The heat releases, combustion rates, and long horizontal flame travel mentioned before are desirable although not always attainable because of physical restrictions and load conditions. Cross-fire air jets, placed at or near the front corners of the furnace and pointing downward slightly and towards the rear of the grate, have been successful in reducing smoke and flyash emission.

Maintenance of a uniform pressure drop through the fuel bed as its thickness varies between cleanings is desirable for economy and to prevent fuel being lifted from the grate and carried through the boiler as flyash. Several control devices are available for this purpose. One type is actuated by the drop in pressure across an orifice in the main air duct, to maintain a constant volume of air through the fuel-bed for every main fuel-air setting. The furnace draft controls the uptake damper in this case and is independent of the other controls. Another control arrangement operates the main uptake damper direct from the steam pressure, with the forced-draft fan operating according to furnace pressure.

Even with conservative furnace design and operation, flyash carryover with certain coals cannot be predicted. Where flyash becomes excessive, collecting hoppers in the rear passes of the boiler and fitted with means for dumping or returning to the furnace may solve the problem. Means for frequent removal of the flyash, whether from hoppers, behind the bridgewall, base of stack, or along the breeching bottom, must be provided to prevent restricting gas-passage areas and sudden lifting of large quantities of flyash.

The final solution of KB's problem may be some sort of flyash collector. The second sketch shows some of the types available. In selecting a flyash collector consideration must be given to the smallest size of particles it is desired to remove and to the separation efficiency of the units. Size-frequency distribution for fly-

(*Continued on page 150*)



ARGUMENT CORNER

Open Letter to George Edwards

I ALWAYS ENJOY READING "The Operating Engineer," particularly the "Practical Aids to Operation." Month after month I have been studying the various types of clamps and wrenches worked out by C H Willey of Penacook, N. H. That man is certainly clamp-minded, and many of his designs are mighty useful.

That gives me an idea. Every practical engineer knows that "how to hold it" is the biggest problem on many mechanical jobs, and has had to make special fastening (and unfastening) devices to meet unusual situations. How about running a "clamp symposium" in The Operating Engineer? Let's share our brains and experience!—L F JONES, *Buffalo, N.Y.*

Good idea! Readers of the Operating Engineer may consider this an invitation to mail in their sketches and descriptions of unusual holding devices (including devices for forcing units together or apart), telling what they are used for. Kinks shown should be original and likely to be useful to other power or maintenance .men.—GEORGE EDWARDS.

Corrections on Combustion Section

ON PAGE 73 of "Fuels and Combustion," it was stated that newly developed coal data books would soon be published by the Consumers' Counsel, Bituminous Coal Division, Dept of the Interior. This should have been the Consumers' Counsel Division, Office of the Solicitor, Dept of the Interior.

On page 77, a *therm* was inadvertently defined as 1,000,000 Btu when it obviously should have been one zero less, or 100,000 Btu.

The Old Chief's Helpers Are Important

THE "OLD CHIEF" series has interested me very much.

It is a curious thing how, by the time a man has reached The Old Chief's stage in life, he seems to have acquired a Socratean philosophy along with a dog-eared diploma from Knocks College, as well as a habit of weighing his fellow toilers and the ability to estimate closely their capabilities and peculiarities.

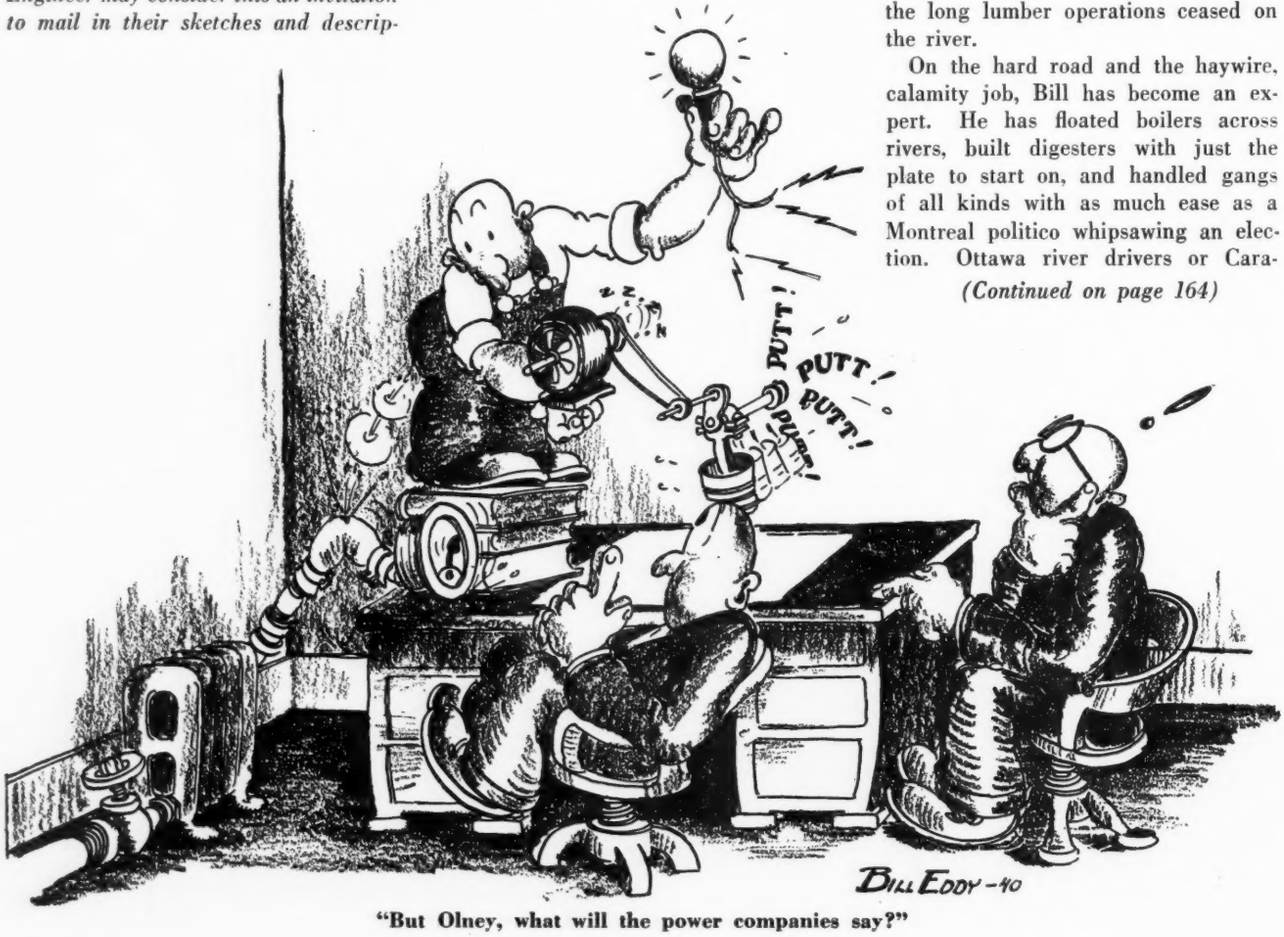
Take the case of Bill Rose, for instance.

Bill was a product of the eastern townships, where the habitants invariably referred to him as Bilrose. He's a rugged individualist who hogheaded on the old Leaky Roof railroad up around Asbestos in the old days. From pushing a steam growler, he graduated —perhaps by special request—to the woods. Then he logged, lumbered and ran sawmills until he was "pushing" outfits on the Saint John for one of the hardest and toughest crowds that ever stole a woodlot.

During these (shall we say formative?) years, Bill acquired a vocabulary, a knowledge of steam plants and a method of getting thing done that have stood him in good stead since the long lumber operations ceased on the river.

On the hard road and the haywire, calamity job, Bill has become an expert. He has floated boilers across rivers, built digesters with just the plate to start on, and handled gangs of all kinds with as much ease as a Montreal politico whipsawing an election. Ottawa river drivers or Cara-

(Continued on page 164)



"But Olney, what will the power companies say?"

Figuring Water Pressure

By
PHIL SWAIN

HOW TO FIGURE PRESSURES (page 115, Jan POWER) showed that a weightless fluid *at rest*, in a connected system of pipes and tanks, has the same pressure in all parts of the system, and that the pressure acts equally in all directions. Two things remain to be considered—the effect of the *weight* of the fluid and the effect of its *motion*. We'll take up weight here, motion next month.

At 60 F, water weighs 62.4 lb per cu ft and its weight does not depart from this figure by as much as 1% between 32 and 100 F.

Effect of Depth

The open-top box shown in Fig 1A is 1 ft sq. If it is brim full of water, what is the total pressure on the square piston 3 ft down? Weight of water in the box is 3 x 62.4 = 187 lb. The sides of the box, being vertical, carry no part of this weight, so the downward force on the piston must be 187 lb. The pressure, therefore, is 187 lb per sq ft, or 187 ÷ 144 = 1.3 lb per sq in.

Now consider a larger open-top tank *B*, with a 1-ft square piece of thin sheet metal set horizontally in the water 3 ft below the surface. The full 187 lb weight of 3 cu ft of water pushes *down* on the *top* of this sheet exactly as in the case of the piston *A*. Balancing this is 187 lb pushing *up* on the *bottom* of the sheet, since pressure at a given level acts equally in all directions. At any depth under the free surface of water exposed to atmospheric pressure, the pressure in lb per sq ft equals the depth in feet multiplied by 62.4.

Fig. 2*A* shows a column of water 1-in. square and 1-ft high. Its weight will be 62.4 ÷ 144 = 0.434. It follows that the gage pressure at a point 1 ft below the surface of water exposed to atmospheric pressure will be 0.434 lb per sq in. For any other submergence (or "head") multiply the submergence in feet by 0.434 to get the pressure in lb per sq in. If the free surface of the water is under pressure, add this to the pressure gained by submergence.

A column of water 1 in. sq and 2.3 ft high (Fig. 2*B*) weighs 1 lb. Therefore, 2.3 ft of head will create a pressure of 1 lb per sq in.—convenient to remember.

Problem: What head of water will create a pressure of 50 lb per sq in.? *Answer:* 50 x 2.3 = 115 ft.

Buoyancy

Twenty-two centuries ago Archimedes discovered that a body partly or wholly submerged is buoyed upward by a force equal to the weight of water displaced. Thus, if the dead weight of a ship and contents is 50,000 tons, the water displaced by its hull below the water line must weigh 50,000 tons.

Fig. 3 shows how Archimedes' Law follows directly from the increase of water pressure with depth. Start with a 1-ft cube of wood weighing 40 lb, and push it down until its top is flush with the water surface. Since the bottom of the cube is now submerged 1 ft, the upward force on this whole bottom will be 62.4 lb. This must be the buoying effect, since there is no water pressure on the top of the cube and since the horizontal pressure on the sides of the cube has no vertical effect. Subtracting the weight of the block, we get a net buoyancy of 62.4 — 40 = 22.4 lb.

This is *not* changed if the block is submerged more deeply. If the block is submerged 1 ft, for example, as shown at *B*, there will be a downward force of 62.4 lb on the top, but the upward force on the bottom (now submerged 2 ft) will be 2 x 62.4 = 124.8 lb, so the difference will still be 62.4 lb as before, and the net buoyancy 62.4 — 40 = 22.4 lb.

In general, any body partly or completely submerged loses weight equal to the weight of water displaced. Naturally, therefore, a floating body sinks until it displaces its own weight of water. Thus, a block of wood two-thirds as dense as water will float with two-thirds of its volume submerged.

Illustrating the rule explained earlier (that pressure increases 0.434 lb for every foot of submergence), Fig. 4 shows the pressures at various levels in a piping system connected to an open roof tank. Note that pressure shown are correct only when water is at rest. Flow of water in any part of the system will greatly disturb the pressure distribution.

This article, and last month's, give all the data necessary to figure pressures at any point in a gas or liquid *at rest*. Some of these relations are changed greatly as soon as the water starts to move. "Water in Motion" (through pipes, orifices, etc.) will be the subject of the article in March POWER.

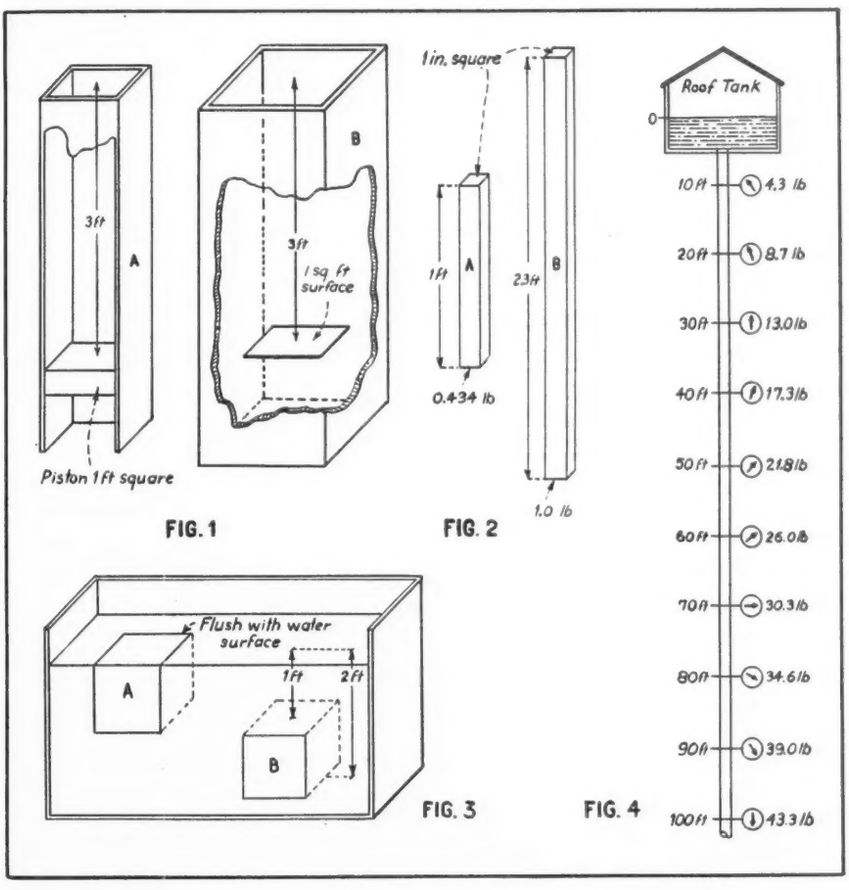


FIG. 1 FIG. 2 FIG. 3 FIG. 4

Fig. 1—The pressure on one sq ft submerged 3 ft is three times the weight of 1 cu ft of water. Fig. 2—Study of the weight of water columns 1 in. square shows that 1 ft of head produces a pressure of 0.434 lb per sq in., and that 2.3 ft head produces 1lb per sq in. pressure. Fig. 3—Any body partly or completely submerged loses weight equal to the weight of water displaced. Fig. 4—Water pressures at various levels in a system connected to a roof tank

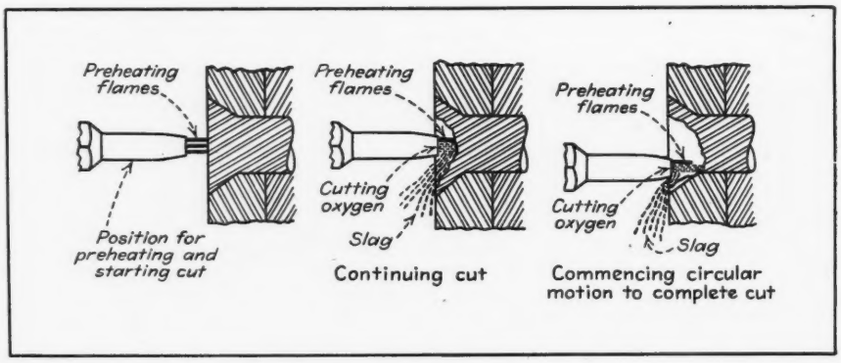
HOW TO CUT RIVETS WITH A BLOWPIPE

REMOVING RIVETS from steel structures is often a slow back-breaking job with sledge hammer and chisel, one that frequently results in damage to steel work, skinned knuckles and upset tempers. Today, these evils have been cured by the development of acetylene cutting blowpipes equipped with nozzles specially designed for rivet cutting.

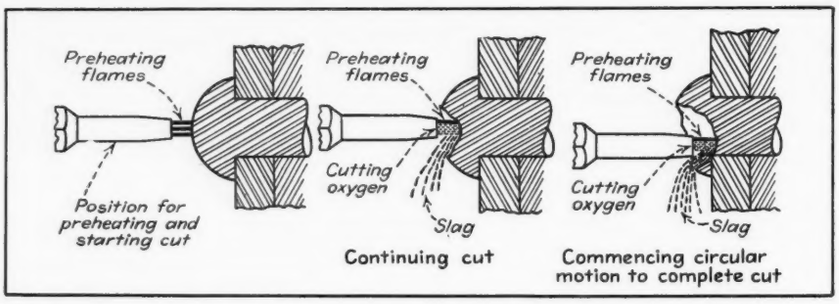
Although rivet heads can be taken off readily with the standard cutting nozzle, the fastest and most economical method uses a special low-velocity rivet-cutting nozzle. This nozzle differs from the standard unit mainly in its larger cutting-oxygen nozzle, in being 50% faster for cutting button-head rivets, and in being the only satisfactory one for countersunk rivets.

This low-velocity rivet-cutting nozzle operates effectively at a cutting-oxygen pressure of 20 to 25 lb per sq in. for any type of rivet up to 1-in. diameter. Larger rivets may require slightly higher oxygen pressure, depending upon the size of the rivets.

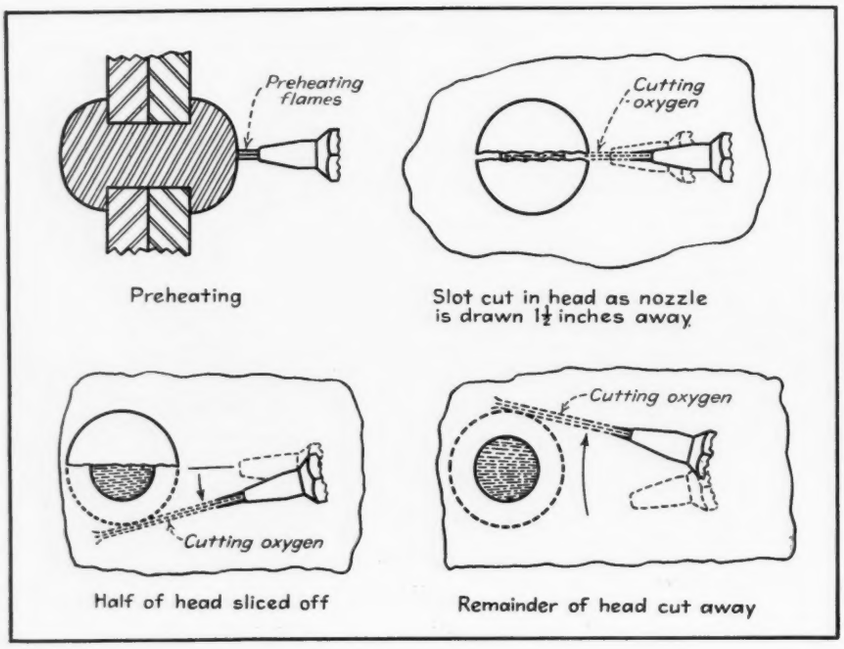
Courtesy Linde Air Products Co



COUNTERSUNK RIVETS—On vertical joints, direct the preheating flames on center of rivet head, holding cutting nozzle at right angles to plate. Hold blowpipe steady until area directly below preheating flame becomes red hot. Open cutting-oxygen valve. As metal oxidizes, swing blowpipe with a slow circular motion in a circle about ¼ in. in diameter. When coned head is burned through to rivet shank, remove rest of head with one circular wiping motion, working outward from the center and always directing nozzle at base of countersink.



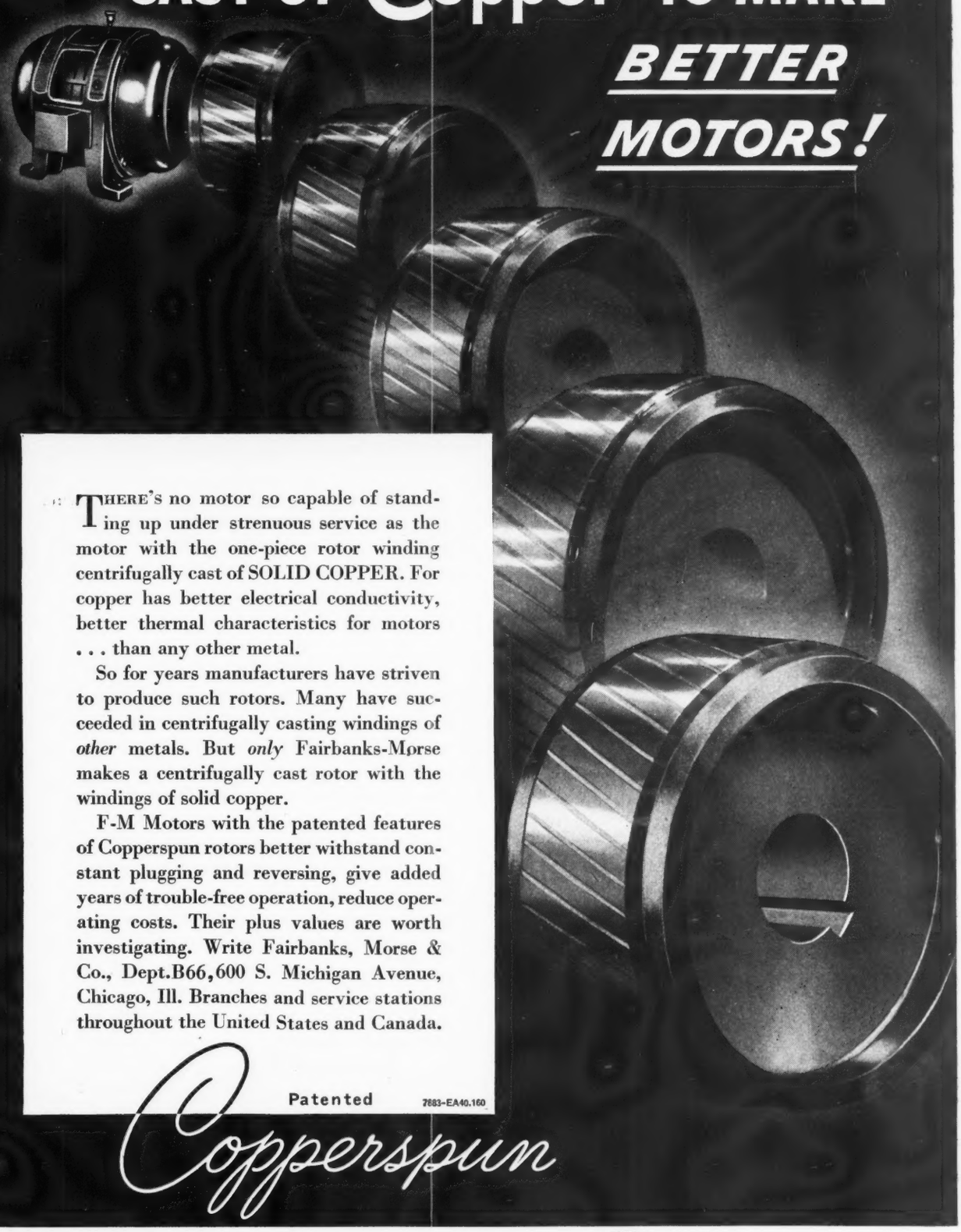
BUTTONHEAD RIVETS—Direct the preheat flames against center of rivet head to bring metal quickly to kindling temperature. Open oxygen valve and burn rivet head until shank is reached, as in the case of a countersunk rivet. Remove rest of head by a single circular wiping movement. Adjacent plate is not affected because of slag layer between rivet head and plate.



RIVET CUTTING WITH STANDARD NOZZLE—Use size nozzle and oxygen pressure recommended by blowpipe manufacturer for cutting steel 1 in. thick. Preheat rivet head. Hold nozzle parallel with sheet surface and cut slot in rivet head from top to underside of head. As cut nears plate draw nozzle back at least 1.5 in. from rivet. Just as slot reaches plate, swing nozzle through a small arc to slice off one-half of rivet head. Immediately swing nozzle in opposite direction to take off other half of rivet head.

In all three cases, once heads are burned off, the good old sledge hammer and punch can quickly knock the rivets from their holes.

CAST OF Copper TO MAKE BETTER MOTORS!



THERE'S no motor so capable of standing up under strenuous service as the motor with the one-piece rotor winding centrifugally cast of SOLID COPPER. For copper has better electrical conductivity, better thermal characteristics for motors . . . than any other metal.

So for years manufacturers have striven to produce such rotors. Many have succeeded in centrifugally casting windings of *other* metals. But *only* Fairbanks-Morse makes a centrifugally cast rotor with the windings of solid copper.

F-M Motors with the patented features of Copperspun rotors better withstand constant plugging and reversing, give added years of trouble-free operation, reduce operating costs. Their plus values are worth investigating. Write Fairbanks, Morse & Co., Dept.B66, 600 S. Michigan Avenue, Chicago, Ill. Branches and service stations throughout the United States and Canada.

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What Is Quality in a Lubricant?

Charles H Bromley, lubrication engineer, shows how a high-grade lubricant may fail to give high-quality lubrication unless its characteristics fit the job

▶ SELECTION OF LUBRICANTS is based almost entirely upon the user's confidence in the seller and not, as with most other commodities, upon technical tests and standards of quality measurement. Yet there are accepted test methods for every particular quality. One would infer that because so few users buy their lubricants on specification there must be sound reasons for selection based upon confidence. Such inference is correct. Yet to the technically-minded this may not make sense. What is the explanation?

We must begin with fundamentals:

1. We must always remember that a lubricant is a commodity, while lubrication is a function. The two are related yet wholly unalike.

2. Price is not at all indicative of the lubrication quality of an oil. There are some exceptions, as, for example, steam turbine oils, which are made to suit the well-known, predictable and usually not widely varying conditions of that service.

3. Specifications of a lubricating oil are of little or no value to a user unless interpreted and evaluated in relation to all the conditions of the specific service under which the oil is to function.

4. Lubricants and lubrication are not well understood generally even among engineers and chemists. By and large these men make no pretense of understanding them.

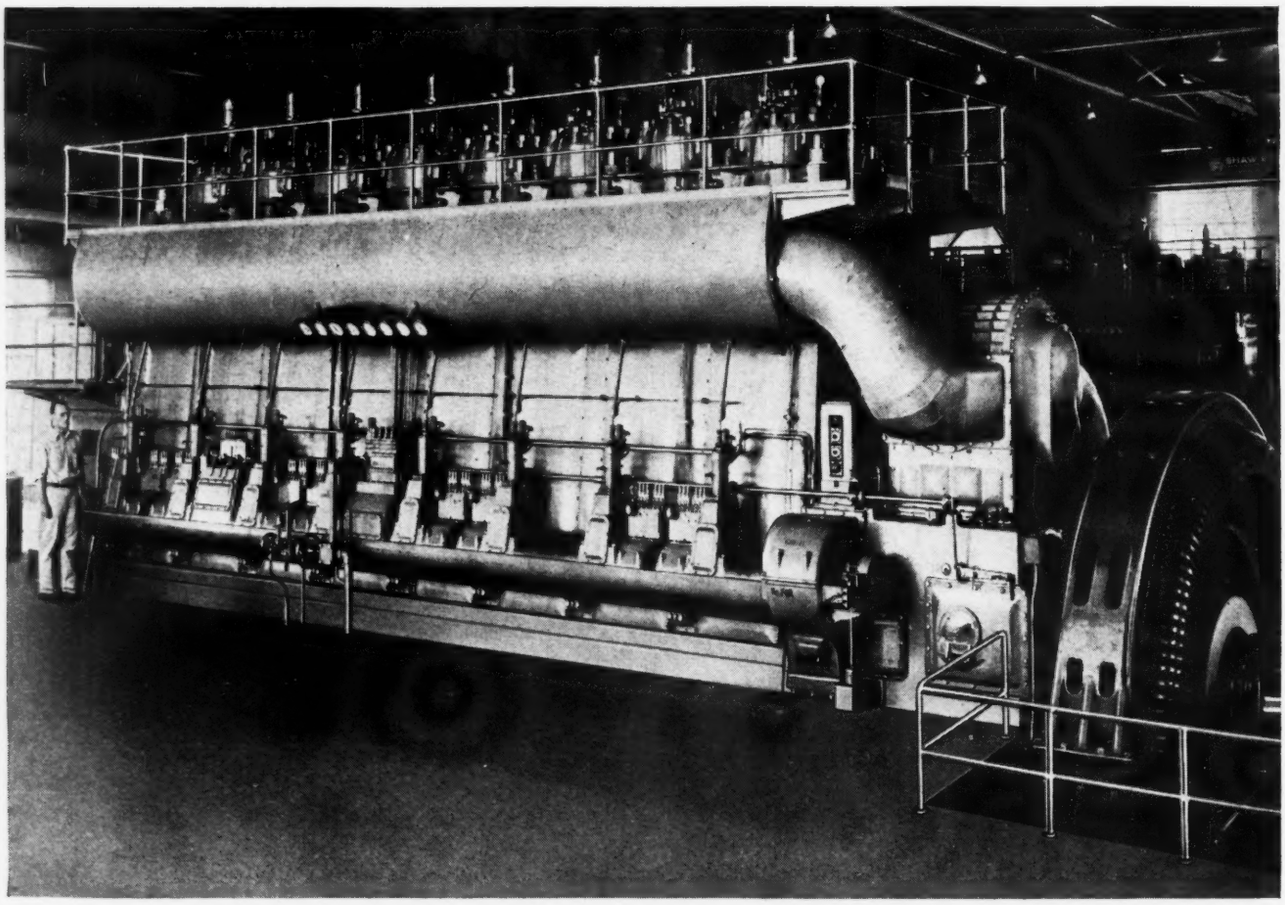
5. Compared with most commodities, materials and supplies purchased for the average plant, lubricating oils and greases are by their nature less chemically stable and are therefore sensitive to the influences of wide variations in temperature, oxygen supply, moisture, atmospheric dust and other conditions to which they are exposed.

6. It is obviously impracticable to store in the oil house all the oils and greases necessary to have a lubricant ideally suited to each set of conditions throughout the plant. Therefore, compromises on quality are necessary.

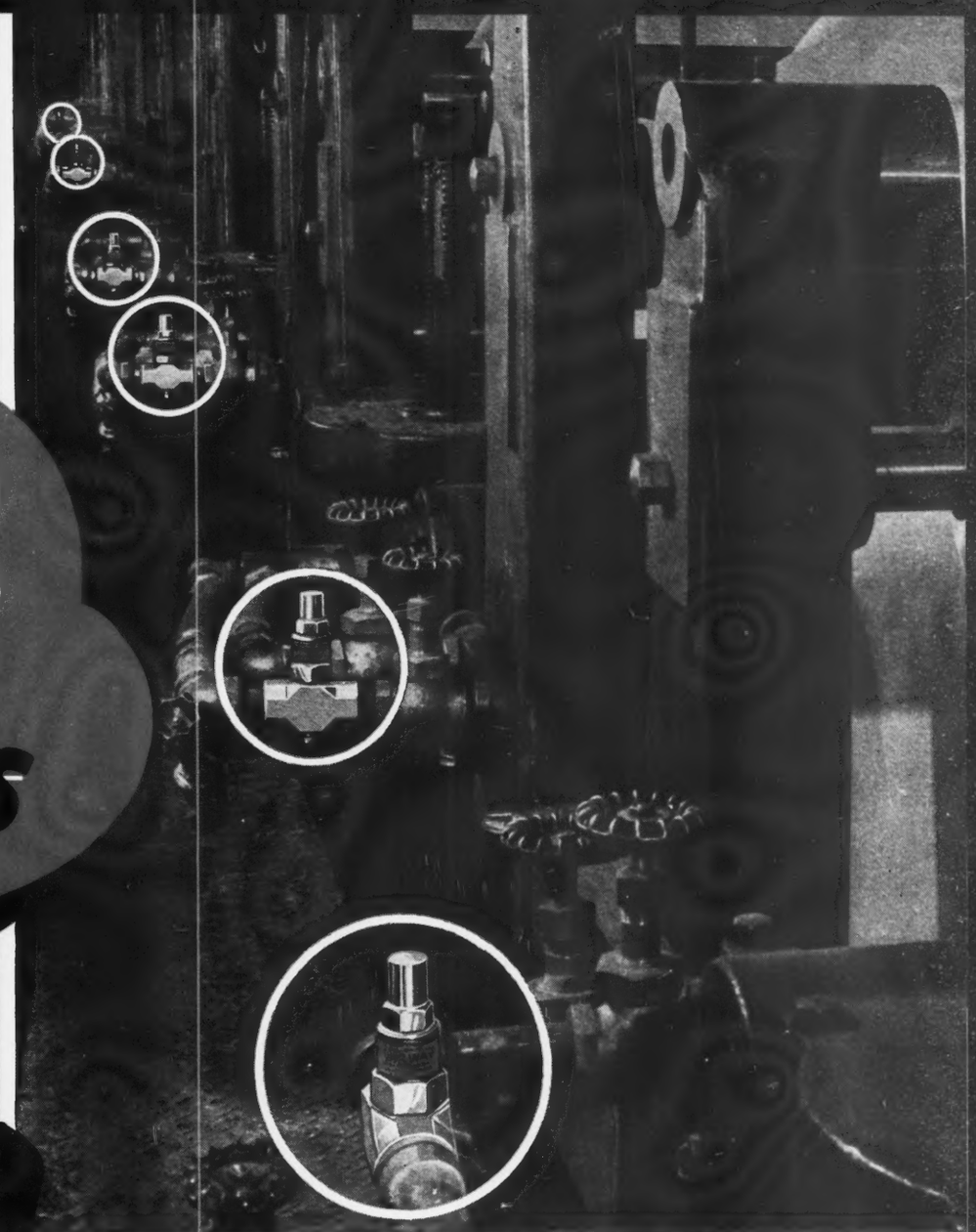
7. Quality specifications as used by

(*Continued on page 118*)

To give successful performance in a diesel, lubricating oil must be highest quality



YARWAY IMPULSE TRAPS SPEED THE NEWS



12 Yarway Traps Drain Drying Cylinders on Giant Gravure Machine

IN Louisville, Ky., that Rotogravure Supplement that brings you the News in Pictures, is hurried on its way by Yarway Impulse Steam Traps.

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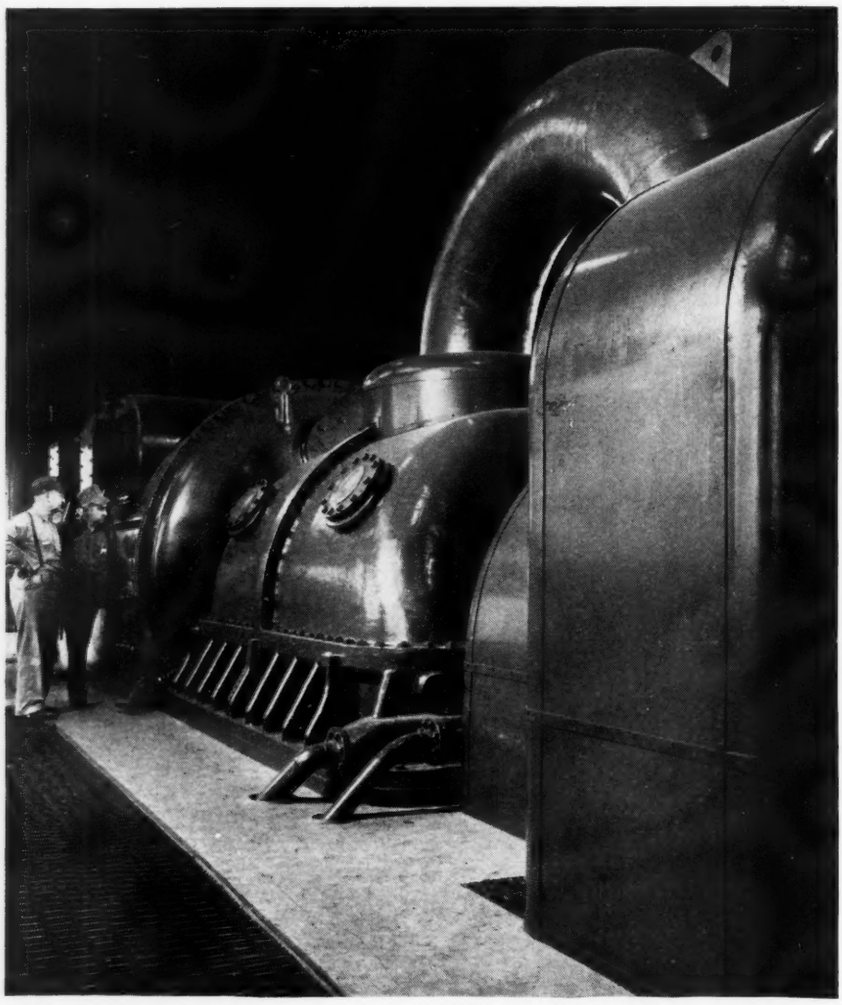
YARWAY IMPULSE STEAM TRAP

What Is Quality in a Lubricant?

(Continued from page 116)



When oil quality is right, lubrication of a steam turbine is simple and inexpensive

the oil refinery are intended to control the manufacture of the oil so it will conform to the industry's generally accepted standards. In nearly all cases these specifications have no definite, specific relation to the conditions of service under which the oil will lubricate. Such would be impossible, for there are relatively few oils, while conditions vary without limit. For example, to meet satisfactorily the different conditions of temperature, wet and dry steam, piston speeds, loads (quantity and variations), chemical nature of the condensate, method of application of the oil, etc, any large oil company makes available 15 to 20 different steam-cylinder oils.

From the foregoing we may conclude correctly that quality in a lubricant from the user's point of necessity is not easily measured. Any one specific quality, such as flash point or vaporizing temperature, viscosity or flow behavior over a wide temperature range, resistance to emulsification with water, can be determined by accepted tests. But to evaluate quality in terms of giving correct lubrication under a given set of conditions and their variables we must know all about these conditions and how to relate each specific quality to them.

Here, of course, is where lubrication experience is paramount. To realize this fully, recall that few oil-refinery chemists would have the courage to make a lubrication survey of a plant, yet we may consider these men experts in the qualities of lubricants from a refinery standpoint.

Service performance is the yardstick of quality measurement by plant engineers and maintenance men. We might call this the "use quality." Such quality implies a quantitative measure: If under a given set of service conditions a given volume of oil or grease gives correct lubrication for a longer time than others, its quality is, for those conditions, better than the others. After all, this is the kind of quality a user wants. But to attain it we must, in nearly all cases, regardless of the kind of prime mover or machine lubricated, go beyond the lubricant itself. You see, always we start with a "commodity," the lubricant; but what we are really after is a "function", lubrication.

Lubrication engineers soon learned that even though you may have the correct lubricant for the job you are only about half way to obtaining the lubrication you want it to give. The other half depends upon using the most intelligent method of applying the lubricant. All steam engineers have learned the truth of this in lubricating steam-engine cylinders. They have found that it is not unusual to lubricate satisfactorily twice as many square feet of surface when oil is adequately atomized as when there is no atomization.

Importance of Application

Perhaps no other factor so much as application influences the quantity of lubrication available from an oil or grease. If "use quality" is uppermost in our minds we will think more and more about oil in terms of drops and less and less in terms of gallons and drums. Not nearly enough credit is given oil for the great quantity of lubrication in it. For example, the number of square feet of friction surface lubricated by a quart of good car oil in a railway car bearing is astounding. Yet certainly there is not more than the equivalent of a few drops of oil composing the whole oil film between the journal and brass at any one time. It is the method of application that achieves the high quantitative value. Many steam turbines have used the same batch of oil for five years with little make-up oil added. Again, high quantitative value had been attained through intelligent application of a good oil.

Many years ago it was common practice to lubricate inclosed gears and pinions, particularly in the steel industry, with highly viscous, black lubricants. With this lubricant not only was consumption relatively high, but power consumption to overcome the high internal friction within the churning lubricant was very large. Many an

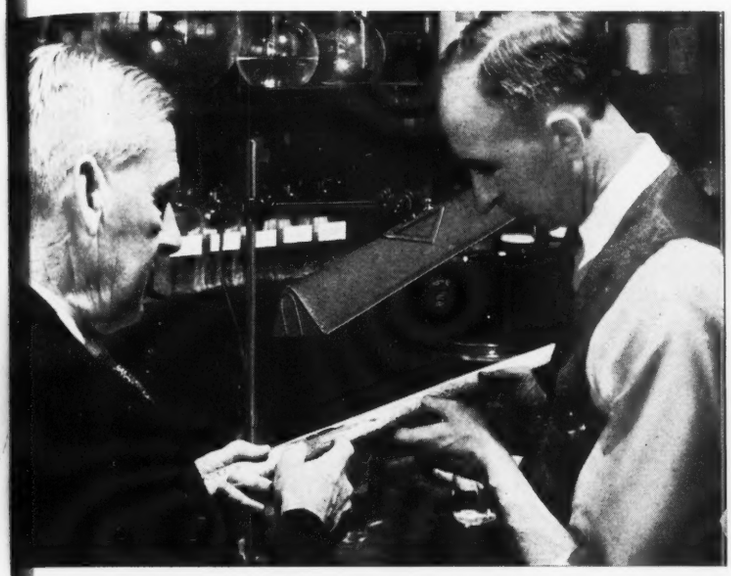
(*Continued on page 120*)

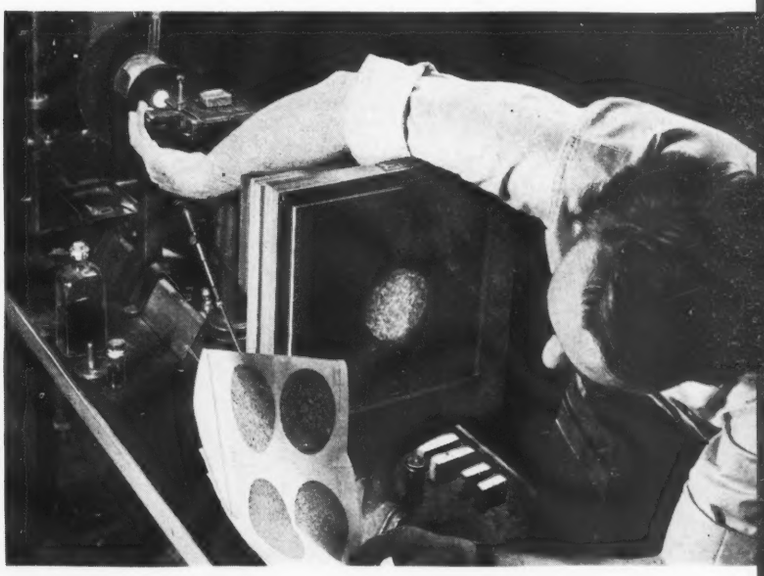
THE TUBE THAT REPAIRED ITSELF

AND DOUBLED ITS LIFE

Well-known is the ability of copper and its alloys to form, under the right conditions, protective films which can repair themselves when broken.

Analyzing such reactions — obtaining *the right metal for the job*—is part of the 3 services Scovill offers its customers: service in *men*, in laboratory-controlled *metals*, and in *manuals* for easy reference. Pictures on this page show these services in action.





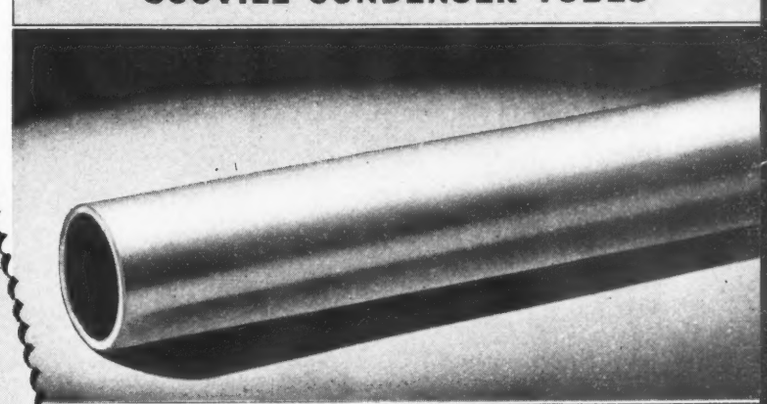
Problem — Corroded tubes like this were costing a large oil refinery replacements every 8 months. A Scovill consultant, called in, found Admiralty tubes operating in vapor-side temperature, of 210°F., with a permeable scale formation favoring dezincification. Contaminated salt to brackish circulating water was used for cooling.

Now It's In This Booklet — Cases like this, covering all varieties of heat exchanger conditions, are the backbone of Scovill's "Condenser Tubes" booklet. Subsections devoted to the corrosion of metals and alloys... may include equally valuable cost-saving hints for *you* ... a copy of this booklet is available upon request. Address Scovill Manufacturing Company, 13 Mill Street, Waterbury, Connecticut.

Solution — Back to Scovill's laboratories went the facts and figures. "At 210°F., recommend 70-30 Cupro-Nickel," said the laboratory men. An inquiry later developed the fact that these tubes lasted 16 months without a failure — a 100% increase in service life.

Reason — the 70-30 Cupro-Nickel tubes had formed a protective film out of their own corrosion products, a film that repaired itself—thanks to Scovill's accurate analysis of the chemical reactions involved.

SCOVILL CONDENSER TUBES



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What Is Quality in a Lubricant?

(Continued from page 118)

old-timer remembers such gear cases so hot he could hardly hold his hand on them.

Today, many similar pinions and gears are lubricated with oils of 500 to 1800 sec Saybolt viscosity at 100 F. In correctly designed continuous oiling and filtering systems, this oil flows in streams on the face of the teeth as they are about to mesh and the oil consumption is almost negligible in a tight system. Again, we have high quantitative value through correct application of a lubricant capable of maintaining a continuous film of required strength, quickly absorbing the heat of friction and quickly giving it up to the cooling media—air and water.

It is, therefore, plain that a particular oil may be of high quality. But for what service? For example, take a most excellent oil of, say, 900 sec Saybolt viscosity at 100 F, treated thoroughly in the most approved manner, highly filtered to a No. 3 or even 2 color. The unsaturated hydrocarbons in this oil are removed to the point of making it very stable chemically and therefore slow to form carbon and sludge and highly resistant to emulsification with water. It originates in a crude that gives it high flash and fire tests and it possesses an excellent viscosity index.

In short, here is an oil having all those characteristics ideal in a steam-turbine oil. Yet if this oil were put to work in a direct-connected turbine-generator unit the engineer would shut it down within 20 min. after starting. Why? The bearings would be running a temperature of perhaps 180 F instead of the normal 130. Yes, the oil has all the most desired qualities except viscosity, which is much too high. It simply will not do for such a turbine, but it will serve beautifully in a diesel.

Take the case of a large steel plant. The mills, gears, pinions and bearings were stream lubricated by oil circulated by a continuous pressure system that contained about 5000 gal of oil, filtered and cooled as part of the cycle. Unintentionally, a small valve in the low part of the precipitation tank was left partly open. When discovered, about 2500 gal of the oil had drained away. Desperately the engineers phoned the purchasing department to have a new oil company who had lately taken over the account to send hurriedly an oil of specifications given over the phone. These specifications were those given by the previous oil company and related to the oil in the system. That day the new oil was dumped into the system. About the end of the third day following, some one discovered that the 5000 gal of oil in the system was like mayonnaise dressing.

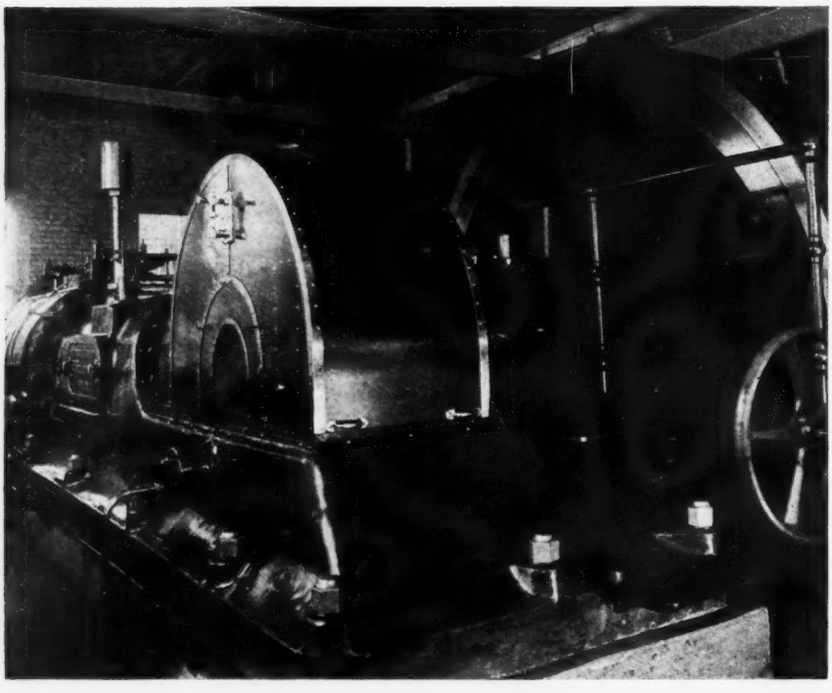
From the frying pan into the fire, truly! What happened? Well, it was another of those cases where quality was not thought out well enough in terms of use. In this system the oil had to pass through about 6 in. of water once during each cycle; also, there was a large cooling coil containing water and surrounded by oil. This coil leaked considerable water into the oil and likely had been doing so long before the gate valve was left open.

The specifications phoned the new oil company were the usual ones sometimes given out by oil companies and gave the gravity, flash, fire and pour points and the viscosity of 100 and 210 F. The new oil conformed to them. Most unfortunately, one of the most important specifications was not mentioned, namely, the steam emulsion number or the Herschel demulsibility. The oil originally in this system could throw off this water; the 2500 gal of new oil could not. A vital specific quality was imperative here; but no one seemed to know it until too late.

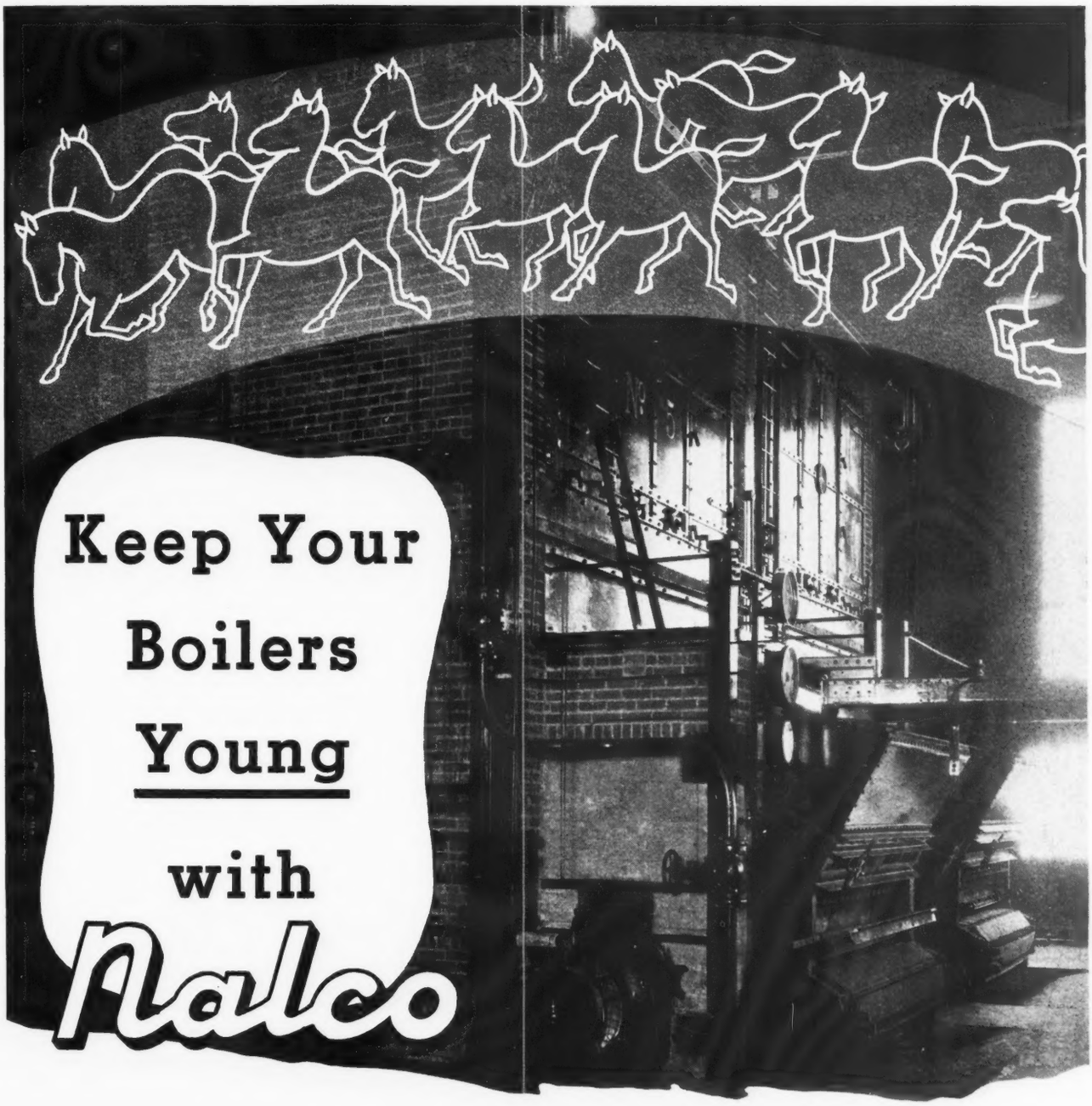
Economic Considerations

Always in lubrication there is the economic consideration. And always quality is inextricably a part of it. For example, it would be unintelligent application of quality to use a highly refined oil in bottle-oilers serving an ordinary lineshaft not subjected to high temperature from the surrounding air. Such an oil would cost, say, 40 cents per gal in drums on contract. An ordinary red or pale oil costing not more than 20 cents a gal would give, qualitatively and quantitatively as much, if indeed not more, lubrication. Another example: Engine No. 1 has its external parts (parts outside the cylinder) lubricated with oil applied through oil cups drop by drop. The used oil falls into pans and, with entrained water and atmospheric dust, is thrown away. No. 2 engine is inclosed; the oil is fed by a continuous circulating and filtering system which uses the oil over and over again. It would be uneconomical to use a high-quality oil on No. 1 and ruinous to apply a poor quality to No. 2.

"Stripped to the bone," successful lubrication is the uninterrupted maintenance of a continuous, unbroken, sufficiently thick film of lubricant between two rubbing surfaces. Actually, achieving this under the widely varying conditions of machine service calls for many niceties in the interpretation of quality.



Steam-engine-lubrication problems fall into two classes: those on engines using saturated steam and on units operating with superheated steam



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ENGINEERS' BOOKSHELF

Electrical Code

NATIONAL ELECTRICAL CODE HANDBOOK (5th Edition-1940). *By Arthur L Abbott. Published by McGraw-Hill Book Co, Inc, 330 W 42nd St, New York, N. Y. 595 pages; 5x7¼ in.; illustrated; tables; fabroid binding. Price $3.00.*

Based on the 1940 edition of the National Electrical Code, this book explains how to apply the Code to all classes of electrical wiring. It presents detailed discussions of the rules wherever anything of practical value can be contributed by such discussions, to make clear their application.

To aid the reader in obtaining a comprehensive grasp of the Code a special grouping arrangement has been adapted that permits placing all rules on one subject together. Under this plan the provisions of the Code are divided into six parts. Part I covers definitions and terms used in the Code. Part II deals with the 15 types of wiring recognized by the Code, together with notes on the application of each type.

Part III discusses the requirements for installing standard materials and apparatus. General requirements applying to all wiring systems is the subject of Part IV. Conditions where special requirements must be applied are dealt with in Part V. All specifications for the construction of materials, devices, apparatus and equipment are placed in Part VI. Tables most frequently referred to by inspectors, contractors and engineers have been assembled in the last part. Its practical treatment throughout makes this book worthy of consideration by everyone interested in wiring problems and the application of the National Electrical Code.

Hotel Engineering

HOTEL ENGINEERING (Vol 1—Water Consumption, Cost and Savings). *By Georges C St Laurent. Published by American Hotel Association, 221 W 57th St, New York, N. Y. 32 pages, 7x10.5 in., paper cover. Price $1.00.*

First of a series on various phases of hotel engineering and economics, sponsored by the Research Department of the American Hotel Association, this pamphlet contains the only detailed information on water consumption in hotels ever published. Increasing water costs make it more than ever important to know how and where the water used in a hotel is consumed, to compare water consumption with hotels of similar size and type and to devise ways and means of cutting down water consumption.

The heart of this pamphlet is the 14 pages of tables giving actual figures on water consumption for a large number of hotels, grouped according to type. In addition, the book tells what to do if water consumption is high, and lists many ways to cut down consumption.

Refrigeration

REFRIGERATING DATA BOOK AND CATALOG, 1940. (Vol 2, Refrigeration Applications). *Published by the American Society of Refrigerating Engineers, 37 West 39th Street, New York, N. Y. 413 text pages, 148 catalog pages, 6x9-in., illustrated, fabrikoid binding. Price $4.00.*

Engineers familiar with the previous Data Books will welcome this new volume, which covers applications of refrigeration, as a useful addition to the Data Book of 1939, which covered refrigerating machinery and methods. In the future, the Society plans to maintain this 2-volume arrangement, issuing a single volume each year.

The wealth of new and specific information in Vol 2 is divided into seven sections: Freezing Processes, Refrigeration in Processing, Cold Storage, Distribution of Foods, Industrial Refrigeration, Comfort Air Conditioning, and Industrial Air Conditioning. Designed for the practical man, each section gives in brief style the latest and best data available on practice in that field. Information on many of the specialized applications of refrigeration has heretofore only been available in scattered technical papers, if at all. The Society has performed a real service for all engineers by bringing this mass of facts together in one volume.

Steam Turbines

STEAM-TURBINE PRINCIPLES AND PRACTICE (Second Edition, 1940). *By Terrell Croft and revised by S A Tucker, Associate Editor of* POWER. *Published by McGraw-Hill Book Co, 330 W 42nd St, New York, N. Y. 298 pages, 5½x8 in., 244 illustrations. Price $3.*

Simple, plain-speaking books made up the Power Plant Series that Terrell Croft wrote. Without mathematics or cumbersome lapses into design theory, they have been for many years the school at which many operating engineers learned necessary fundamentals of power-plant operation. The turbine book in particular bridged the gap between steam-engine experience gained first hand and the then newer era of the turbine.

Revised and extended to cover new types of turbines and their application to both industrial and central-station types of plant, the original direct and explicit style has been retained throughout. Many illustrations of older models of turbines have been kept and afford reference to the great number of these still in active service.

Chapters cover steam-turbine selection, installation, operation, testing and maintenance. Illustrations of governor systems, glands and other physical details include latest types. A new chapter on turbine applications describes the proper use of superposed turbines, regenerative feedwater heating and extraction for process.

Thermodynamics

ELEMENTARY ENGINEERING THERMODYNAMICS (Second Edition, 1941). *By V W Young and G A Young. Published by McGraw-Hill Book Co, 330 W 42nd St, New York, N. Y. 243 pages, 6x9 in., illustrated, abridged steam tables, Mollier diagram. Price, $2.75.*

Revised edition of this standard college text is based on new steam table data and contains enlarged problem lists. Because emphasis is laid on explaining certain of the thermodynamic conceptions that offer particular difficulty to the average student, this book continues to offer a brief but thorough course in fundamental theory.

Welding

ARC WELDING INSTRUCTION COURSE. *Published by Air Reduction Sales Co, 60 East 42 St, New York, N. Y. Price of lectures $1.00, of exercises $1.00.*

These heavily cloth bound books are 8½x11 in. size, half-inch thick. The "lecture" book, designed chiefly for the guidance of teachers of arc welding courses, should be extremely helpful to any engineer or mechanic who wants to study the subject on his own. His greatest help, however, will come from the book of "exercises", which is a masterful and practical presentation of the steps in welding, all illustrated by very clear sketches. These books should be in the library of every welder and would-be welder.

Current Comment

Removing Water from Engine Flywheel Pit

I HAVE NOTICED ESB's question in August, 1940, POWER, regarding a small pump to lift water from an engine flywheel pit, and none of the answers mentioned the possibility of using a McDaniels tee.

This can be purchased for a few dollars already made with steam jet cast right into the tee, from any pipe-fitting supply house, and it works very successfully for medium lifts.

Flint, Mich. F ELWELL

Indicator for Bearing Temperatures

PLEASE REFER TO THE QUESTION shown on page 111 of the September issue of POWER. "Can POWER readers tell me how to build a simple device that will give an alarm or that will indicate when the bearing temperature reaches the danger point.—RWO".

(Continued on page 180)

Dollars in Operating Costs

WHEN YOU ASSIGN VALVE JOBS TO

Jenkins 106-A

COMBINATIONS WITH JENKINS RENEWABLE DISCS

We built this Jenkins 106A "Family" for the Engineer who wants absolutely drop-tight service, with maximum ease of maintenance . . . and is willing to pay a little more for these money-saving advantages.

It is revolutionary in design—from the extra convenience features, to the complete interchangeability of parts as pictured below. Note how the bonnet is made in one sturdy piece—how it can be taken off and reassembled repeatedly without danger of distorting or springing the body.

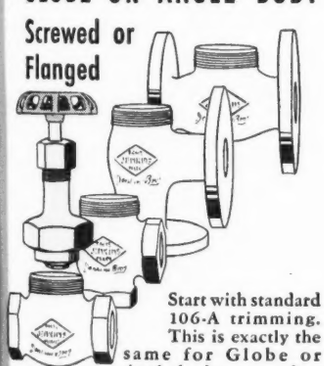
Then there is the convenient slip-on, stay-on disc holder that takes but a few simple operations to replace a disc and get "good-as-new" valve performance.

Now see the unique way Jenkins 106A "Family" works together—so that you can adapt valves to any service without removing bodies from the line. This interchangeability, which no other valve manufacturer offers you means faster, easier maintenance with a minimum number of stock parts.

These valves are obtainable from your supply house. For further details ask for descriptive Bulletin No. 189.

JENKINS BROS., 80 White Street, New York, N.Y.; Bridgeport, Conn.; Atlanta, Ga.; Boston, Mass.; Philadelphia, Pa.; Chicago, Ill.; Houston, Texas. Jenkins Bros., Ltd., Montreal; London, England

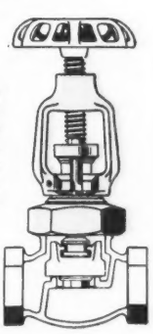
GLOBE OR ANGLE BODY Screwed or Flanged



Start with standard 106-A trimming. This is exactly the same for Globe or Angle body, screwed or flanged.

with OUTSIDE SCREW AND YOKE

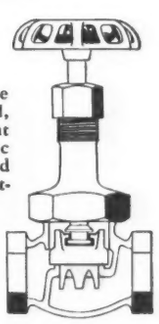
Similarly all four body styles can be fitted with the one standard O.S.& Y. trim. In other words, if service conditions necessitate it, the valve can be quickly converted merely by changing the trim.



for THROTTLING SERVICE

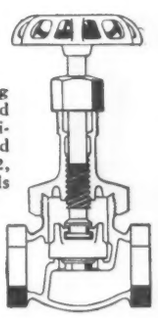
If the valve is to be used for close control, simply remove the nut which holds the disc in the disc holder and replace with this throttling nut Fig. 344.

For use on Fig. 106-A to 109-A inclusive. Also 106-AY to 109-AY.



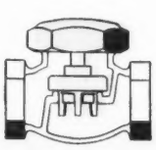
for QUICK OPENING

For services requiring quicker opening and closing, simply substitute this bonnet and spindle from Fig. 942, in which the threads are pitched more sharply.



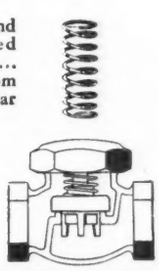
for LIFT CHECKS

Globe and Angle bodies can be fitted with this one set of trimming for lift check service. Trim consists of Cap, Disc Holder and Disc Holder Nut from Fig. 117-A.



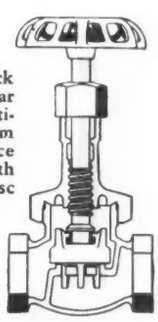
for SPRING LOADED CHECKS

For air compressor and other Spring-loaded check valve services... simply add Spring from Fig. 655-A to regular lift check valve.



for STOP AND CHECK

For Stop and Check service, use the regular 106-A trim but substitute this Spindle from Fig. 630-A and replace regular disc nut with the check valve disc nut.



DISCS MADE BY JENKINS

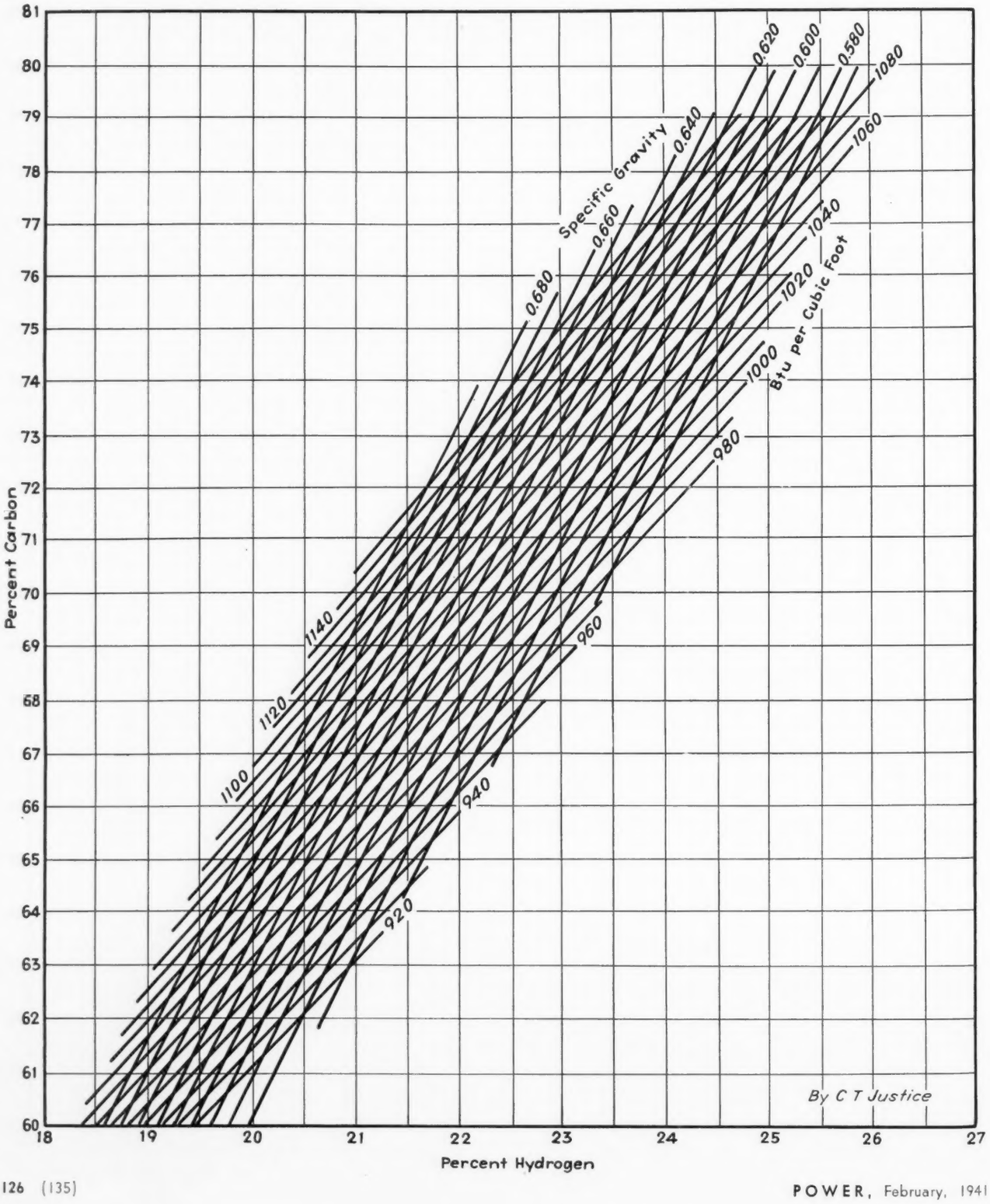
For all these valves, pick the disc *exactly* compounded for the pressure, temperature and fluid to be handled —hot water, cold water, steam, oil, gasoline, air, gas, and other services.

Number 103

Natural-Gas Analysis Chart

APPROXIMATE COMPOSITION of natural gas on a weight basis can be found from this chart if the heating value and specific gravity are known. The gas from which this chart was computed is a composite of many fields ranging in heating value from 930 to 1150 Btu and in specific gravity from 0.570 to 0.650.

Specific gravity, referred to air, and Btu per cubic foot at 30-in. Hg at 60 F are usually known in a routine way to most plants that burn large quantities of gas. Since all the hydrocarbons present are included in the chart, the analysis so obtained is quite complete.



© POWER

REPEAT ORDERS

for COPES Flowmatic Regulators have been placed by these users:

USER (Any name on request)	Date	No. of Boilers	WSP Lb.	Max. Evap. Lb. an Hr.
Chemical Manufacturer	Plant A	1937	1	1325	300,000
	Plant B	1940	4	420	300,000
Industrial Company	Plant A	1938	1	450	100,000
		1940	1	450	100,000
	Plant B	1940	1	450	48,000
	Plant C	1940	1	500	50,000
	Plant D	1940	1	600	70,000
Oil Refinery		1937	1*	600	350,000
		1940	1*	620	350,000
Oil Refinery	Plant A	1939	1	650	125,000
	Plant B	1940	1	460	120,000
Paper Mill		1937	1	600	100,000
		1938	1	600	100,000
Paper Mill		1938	2	440	35,000
		1940	2	440	52,500
Steel Mill		1937	1	130	25,000
		1939	1	130	25,000
Steel Mill		1938	1*	400	85,000
		1939	1*	400	85,000
Steel Mill	Plant A	1938	3	250	150,000
	Plant B	1939	1	660	150,000
	Plant C	1940	1	175	40,000
		1941	1	175	40,000
Textile Manufacturer	Plant A	1937	2	450	200,000
	Plant B	1939	3	600	75,000
		1940	1	600	200,000
Utility Company	Plant A	1937	1	850	400,000
	Plant B	1938	1	875	400,000
		1939	1	875	400,000
		1940	1	875	550,000
	Plant C	1939	2	875	400,000
Utility Company		1938	1	675	150,000
		1939	1	675	150,000
Utility Company	Plant A	1938	3	400	140,000
		1940	2	400	225,000
	Plant B	1939	2	475	200,000
Utility Company		1939	1	1300	300,000
		1939	3	1300	300,000
Utility Company		1939	1*	690	550,000
		1940	1*	690	550,000

*Two COPES Flowmatic Regulators per boiler.

PROMISES might sell a first order—but no one today repeats with any equipment until it has made good in regular service on the job. And the COPES Flowmatic Regulator has done just that for all these users. Since 1937, when the first Flowmatic was placed in service, these 15 users have released 25 repeat orders for this simplified two-element steam-flow type feed water regulator.

All are getting close water level control, with feed flow exactly as needed for their steaming conditions. None have had any particular operating or maintenance problems.

If you want effective feed and level control on your modern boilers, investigate the COPES Flowmatic—now in service on more than 200 boilers. Write for Bulletin 429.

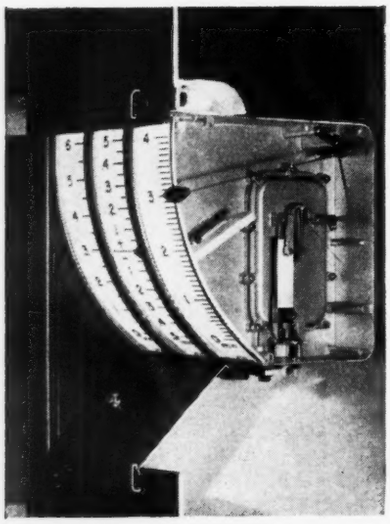
NORTHERN EQUIPMENT COMPANY
211 GROVE DRIVE, ERIE, PA.

Feed Water Regulators, Pump Governors, Differential Valves, Liquid Level Controls, Reducing Valves and Desuperheaters

WHAT'S NEW IN PLANT EQUIPMENT

Multi-Point Indicator

MULTI-POINT INDICATOR indicates drafts, pressures, differentials, and other factors in boiler and furnace operation. Zero adjustments and all piping connections for each gage are accessible from front of panel, and each unit can be withdrawn, like a



book from a shelf, without disturbing other units. Each gage is actuated by sensitive dry-bellows type of diaphragm for ranges from 0 to 50 in. of water. New indicator is supplied with from 2 to 16 compact, interchangeable units. *Republic Flow Meters Co, 2222 Diversey Parkway, Chicago, Ill.*

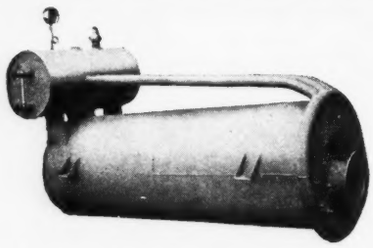
Contactors

COLT GENERAL-PURPOSE CONTACTORS provide safe and convenient method of remotely controlling electric circuits from one or more pushbutton stations or pilot devices. Units are horse-power-rated for motor control and can be employed where

overload protection is not required or is otherwise provided for. They are also suitable for handling single-phase or polyphase ac motors, or for use as flexible relaying devices for control-systems. Contactors can be supplied open as Type *U* or in standard Type *A* sheet-metal enclosure which has knockouts on four sides and back. To facilitate wiring, entire interior may be removed by loosening one self-retaining screw. *Colt's Patent Fire Arms Mfg Co, Electrical Div, Hartford, Conn.*

Waste-Heat Boiler

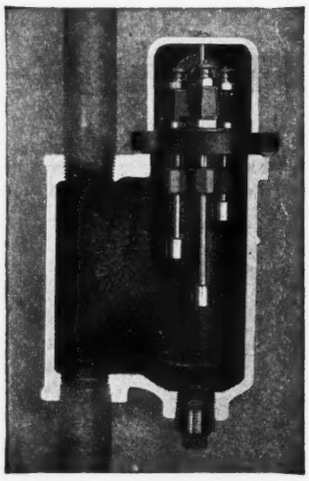
COMBINATION WASTE-HEAT BOILER and silencer provides efficient silencing and at same time collects and uses waste heat normally lost in exhaust. No tubes are used in waste-heat boilers and water heaters. Heat is recovered by simple arrangement of angle irons, which form heating



surface. Device is constructed around Universal silencer principle originated by company, and can be combined with spark-arrestor when required. Design is such that boiler can be operated dry over long periods of time without injury. *Maxim Silencer Co, 85 Homestead Ave, Hartford, Conn.*

Boiler-Water Controls

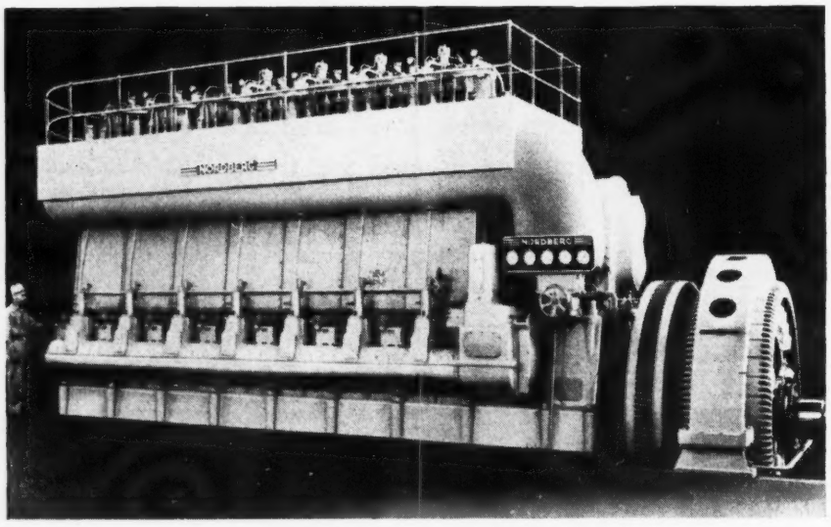
FOR USE ON BOILER-FEED SYSTEMS where pumps are employed to return condensate or add makeup water, boiler-water-level control now available in two new models, for either electric- or steam-driven pumps. Both models utilize motionless-electrode control. Two electrodes, see illustration, of different lengths, are suspended into a chamber which can be mounted on water-



glass column. When boiler-water level falls below longer electrode an electrical circuit is disturbed which, in turn, through a relay, starts pump and keeps it pumping until water in boiler reaches short electrode. Third electrode can be provided to shut off stoker, oil or gas-burner in event pump fails and water falls to dangerous level. Model *E* will start single-phase electric motors as large as 1 hp. For polyphase or larger single-phase motors it functions as pilot circuit to operate a starter. Model *S* controls an electric steam-supply valve. *Johnson Corp, Three Rivers, Mich.*

Diesel Engine

IMPROVED NORDBERG 2-CYCLE DIESEL gives more power in less space, maker says. Convenient access to crankcase is obtained by removal of aluminum covers. Fuel-injection pumps are mounted directly above full-length cam shaft, bringing each fuel pump adjacent to cylinder it serves. Fuel pump may be removed or replaced without shutting down engine. Power-cylinder lubricators are placed alongside fuel pumps and are gear-driven from cam-



For

BOILER FEED LINES

CRANE No. 3644-XR

(600-POUND)

Steel Globe Valves

Crane plug type disc and seat design of Nickel Alloy and Exelloy minimizes damage from wire drawing and foreign matter. Makes long-lasting tight closure and extends service life of valves.

. . . One of 38,000 valves and fittings in the Crane line—each designed to give finest service in a specific need—and quickly available through Crane branches and wholesalers everywhere.

CRANE

VALVES • FITTINGS
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HEATING • PUMPS

CRANE CO., 836 SOUTH MICHIGAN AVENUE, CHICAGO

shaft. Single, positive-displacement blower, gear-driven from crank-shaft, supplies scavenging air in larger models, while reciprocating pumps are used on smaller sizes. All models may be equipped for burning natural gas, and changeover from oil to natural gas may be accomplished quickly without change of major parts and without departing from diesel-operating cycle. Picture shows 7-cyl, 3000-hp, mechanical-injection unit. *Nordberg Mfg Co, Milwaukee, Wis.*

Gate Valves

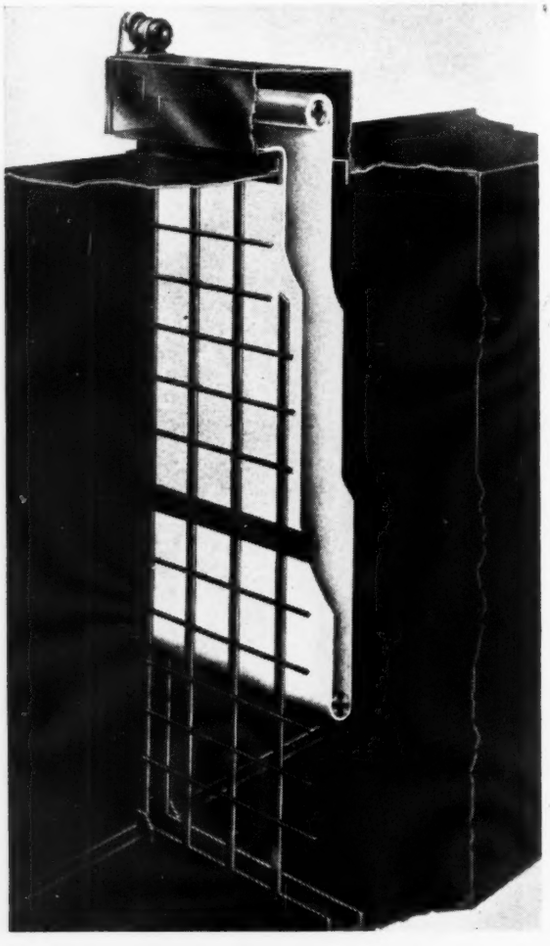
STANDARD IRON BODY wedge gate valves are for 125 lb, steam, 200 lb, cold-working, pressures. Feature of new valves is redistribution of body and bonnet materials. Handwheels are malleable iron, deep stuffing boxes permit generous amount of packing, and body-bonnet joints employ a flat gasket closely bolted together so that gasket-compression is evenly distributed. New line includes both brass-trimmed and all iron patterns with O S & Y or non-rising stem, in sizes 2 to 12 in., inclusive. *Crane Co, 836 S Michigan Ave, Chicago, Ill.*

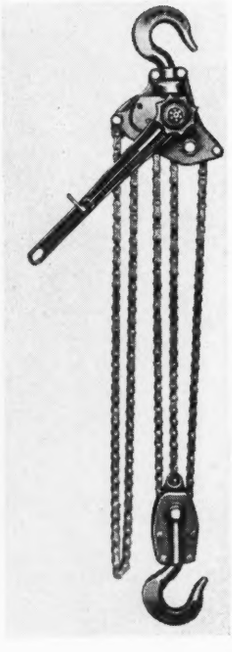
Damper

HEACON DAMPER consists of flexible asbestos curtain held in place against sealing strips in duct by draft, automatically producing tight seal. Need for close fits is eliminated and operation is smooth even if foundations settle or ducts warp. Due to its free movement and light weight, little power is required to operate it. Damper is adaptable to boilers up to 300,000 lb of steam per hour. All gas must pass under damper as compared to conventional dampers that leak on four sides. Thus damper provides constant flow characteristic accurately controlled from 0 to maximum with result that greater variation of efficient output is possible. *Heacon, Inc, Luzerne & Second Sts, Philadelphia, Pa.*

Portable Hoist (below, right)

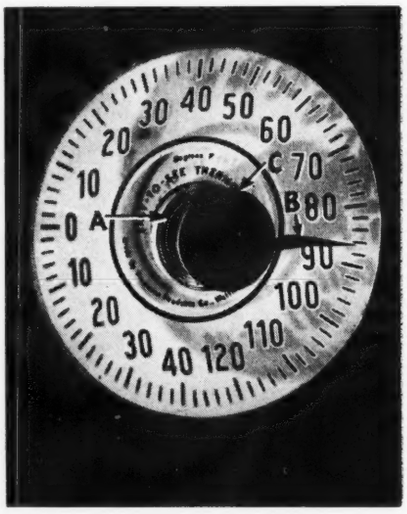
"PUL-LIFT", 4½-ton capacity, has same safety and construction features as previous models. Addition to line brings models available from ¾ to 6 tons. Unit will operate in either horizontal or vertical position, and thus can be used for both pulling and lifting. In case of severe overload, Yale safety hooks open slowly, without fracture, giving ample visual warning of danger and positive protection to operator, load and machine. Self-actuated load brake reduces possibility of flying handle. As load is increased, brake-pressure increases in direct proportion. For operation in close quarters and tight out-of-the-way places, unit has ratchet handle with universal action. Short easy strokes at any point within a complete circle permit operation in most cramped quarters. *Philadelphia Div, Yale & Towne Mfg Co, Philadelphia, Pa.*





Transparent Thermometer

PRECISION thermometer operates by bimetallic strip. Consists of 3-in. concave glass dial with bimetallic strip *A*, mounted in front, with pointer attached to strip. As temperatures increase or decrease strip



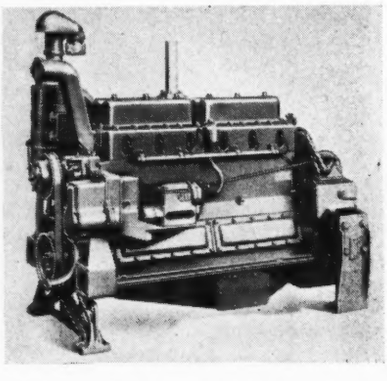
expands or contracts, moving pointer, *B*, around dial. Thermometer is attached by wooden piece, *C*, which is made fast to window by weatherproof cement. *Precision Products Co, Waltham, Mass.*

Bearing Material

FEATURES OF CARBOBRONZE are: ability to carry high loads and speeds, ability to resist shock loads, freedom from any consequential wear, lower friction resistance, and resistance to deformation under heavy loading. Material contains 91.2% copper, 8.5% tin, and 0.3% phosphorous, and is made in tubular form from ½ to 3½ in., OD, within reasonable limits of wall thickness. Rods can be supplied in all sizes from wires up to bars of about 3½ in. diameter. *Revere Copper and Brass Inc, 230 Park Ave, New York, N. Y.*

Gas Engines

THREE MODELS of heavy-duty natural-gas engines are built in 2, 4 and 6 cylinders. Heat-resistant alloy valve seats are provided on all models. Lubricating system provides efficient filtering and full pressure-lubrication to all working engine parts. In addition, there is upper-cylinder



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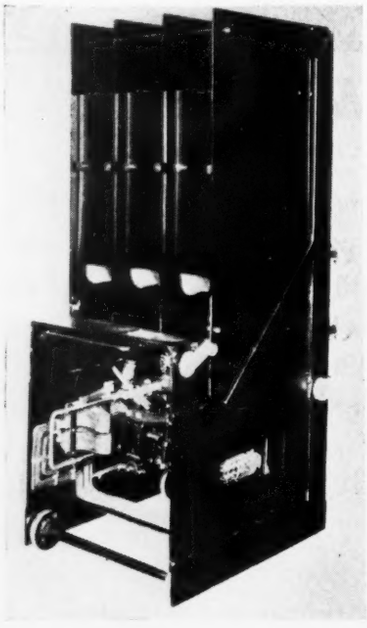
lubricator to provide extra valve-lubrication for use with dry natural-gas fuel. Combination gas-gasoline carburetor is standard equipment, and though engine will burn gasoline satisfactorily for short periods of time, such as for starting purposes when gas is not available, fuel system is set for most efficient combustion of natural gas. Two larger models develop 48 and 74 hp, while smaller unit develops 34 hp at 1650 rpm. *Caterpillar Tractor Co, Peoria, Ill.*

Circuit Breaker

DE-ION AIR CIRCUIT BREAKER employs special magnet coil to draw arc out quicker to be quenched. Closing operation is of solenoid type, with mechanism mechanically and electrically trip-free. Contact-opening is accelerated by strings, principal advantage being its high speed, resulting in only a half cycle of arcing at most



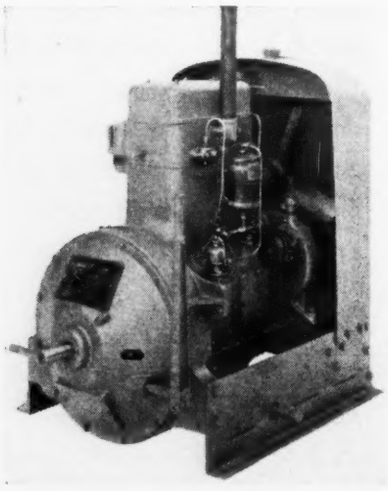
current values. Breaker is compact and easy to install. It can be installed so that access to rear, except for connecting main leads, is unnecessary. Access to contacts for maintenance requires only the removal of light-weight arc chute. Barriers isolate live phases from each other, and from metal enclosure, and on opening of breaker suppress residual arcing-flame and muffle noise. *Westinghouse Electric & Mfg Co, East Pittsburgh, Pa.*

Liquid Level Controls

TWO ADDITIONS to "Magnetrol" controllers announced. Models TF-5 and TF-6 for flange and screw-in mounting respectively, controls are for tank application where it is necessary to maintain liquid-level between certain differential. As electrical units they may be used to energize a pump, solenoid or motorized valve depending on application, including installations where explosion-proof equipment is necessary. They may also be used in alarm system to flash or ring a bell when liquid-level reaches certain point. Using Magnetrol principles, switches employ no stuffing-boxes, bellows, rotary-shafts or packing as media through which movement is transmitted from float to switch element. *Fred H Schaub Engrg Co, 325 West Huron St, Chicago, Ill.*

Diesel Engines

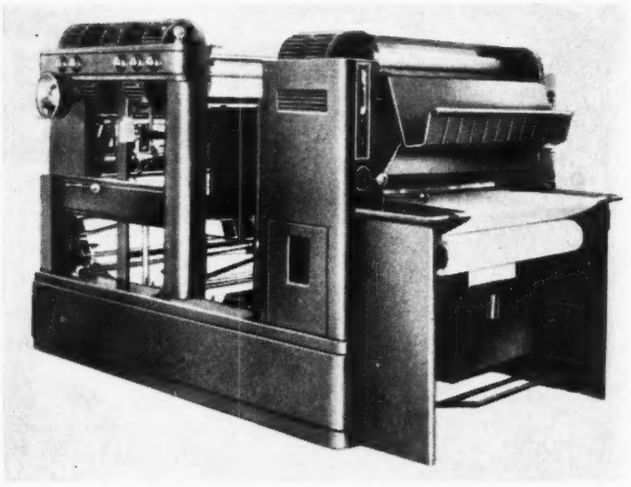
STOVER DIESELS, equipped with Lanova combustion chambers, available in four sizes with a variety of mountings. Models



of 7½ and 10 hp are single-cylinder, while 15 and 20 hp models are twin-cylinder type. Illustration shows conventional stationary mounting. *Stover Mfg & Engine Co, Freeport, Ill.*

Chemical Pump

NELSON CHEMICAL PROPORTIONING PUMP (original description, page 124, February, 1940, POWER) has several improvements, based on data obtained from users of pumps in field. Arrangement of inlet- and outlet-valves on feeding-end of pump have been changed to decrease friction-losses and lend pump a greater volumetric efficiency. All-Monel-metal disks of poppet valves now feature diagonal grooves which impart rotary-motion to disk when in operation, insuring complete reseating of disk



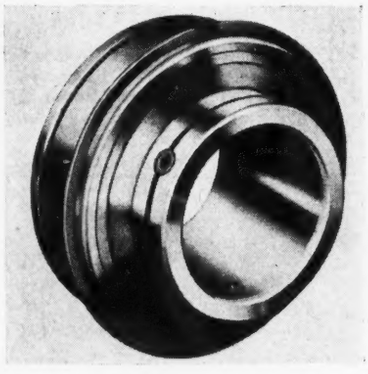
each time valve closes. Conventional grease fitting has been replaced by oil cup, assuring constant lubrication to all moving parts. *D W Haering & Co, Inc, 2308 S Winchester Ave, Chicago, Ill.*

Blueprint Machine (above)

MODEL 22-16 is combination of Model 22 printer and Model 16 washing and drying machine. Features include sliding contact, which smoothes out inequalities present in tracing, and 24⅜-in. of uninterrupted exposure area; 3-speed lamp control, which allows lamps to be operated on 10, 15, or 20 amps; and actinic arc lamps which furnish uniform light emission. Washer has horizontal water-wash that floats exposed paper horizontally, free from wrinkles and tension, and quick-change chemical applicator, which gives change-over from blueprints to negatives in 30 seconds, or vice versa, and provides only method of applying potash to one side and hypo to both sides of paper. *C F Pease Co, 2601 West Irving Park Rd, Chicago, Ill.*

Bearings

INNER-RING BEARINGS, in fractional-inch dimensional bores, are for machine applications on straight shafts, and are equipped



with patented Sealmaster centrifugal labyrinth seal, which keeps out dirt and retains lubricant. No seals in housing required. Annular grease-groove with two holes in outer-diameter of outer race per-

(*Continued on page 138*)

SAFETY WITH *Seamless*

TEN YEARS AGO a remarkable development made its appearance in the flexible metal hose and tubing world. It was seamless metal tubing with all the flexibility of a garden hose.

Since then American Seamless Flexible Metal Tubing has found its way into thousands upon thousands of different applications, each making valuable use of one or more of its unique properties... such as:

No joints, welds, laps, seams or packing where leaks can occur.

It has been flexed millions of times without breaking down.

Available in various alloys, corrosion resistant and strong, and thus useful for *all* industries.

Braids and casings make it as strong, as tough as pipe; but in addition, it's flexible.

In other words, American Seamless is the most dependable tubing you can buy for the conveyance of steam, air, gases and liquids... for connecting moving or misaligned parts. You can read more about American Seamless in SS-25, a 24-page book of facts illustrated by more than seventy-five pictures. Ask for it—no obligation. 40289

In air-conditioning systems, American Seamless eliminates vibration from compressor. See page 12 in Bulletin SS-25 for complete information.

American Metal Hose

ANACONDA
from mine to consumer

The American Metal Hose Branch of The American Brass Company
General Offices: Waterbury, Conn. *Subsidiary of Anaconda Copper Mining Company*
In Canada: Anaconda American Brass Ltd., New Toronto, Ont.

POWER LINES

Skilled-Labor Shortage Predicted in Near Future

The national defense program may run into obstacles early this year, say informed sources close to the government, because of a serious shortage of skilled labor. The concensus of several experts is that a critical shortage will begin to be felt in a number of centers by March and before summer it will become increasingly serious.

According to these sources, labor will have to be drawn from non-essential to defense industries by the thousands, even though industry begins to train and upgrade men immediately. With no more training than has been undertaken so far, the skilled-labor situation is expected to become one of the most serious problems in the defense program.

Although the comments apply directly to industrial manufacturing operations, it may be assumed that the general tightness in the skilled-labor market will have some influence on the power-plant labor situation, particularly as it effects such skilled workers as electricians, steamfitters and maintenance men.

Electrical Brains for Boulder Dam Hydro Plant

The steel-clad switchboards, "electrical brains" for the two new 82,500-kw generators for Boulder Dam are being built at Westinghouse's East Pittsburgh Works. The two new waterwheel generators will supplement eight existing machines of identical rating, in addition to three smaller generators previously installed, to give Boulder Dam the world's largest concentration of electrical power.

The new switchboards (Fig. 1) will carry control equipment, relays, meters, and switches for operation of the new generators. Control scheme of the new machines will fit in with that of the existing power-station apparatus, and the new machines, like the ones now operating, will be under control of the operator in the main control room.

While each power unit at Boulder Dam can be operated independently the operator in this control room, five floors above the generator gallery, can start or stop any one at the press of a button. With other controls, he can connect eleven generators to some 1800 miles of transmission line extending in many directions to receiving stations as far distant as Los Angeles, 290 miles away. Instruments and signal lights on the control desk indicate at all times the operating condition of the system.

Starting and stopping operation of the generators is taken over by the switchboards after the operator presses the control buttons. The starting button actuates a master relay which controls a governor. The governor slowly opens the gates of the water turbine permitting water to turn the rotor of the generator. At the proper time an automatic synchronizer closes the generator circuit breaker, putting the machine on the line. Other relays check speed, oil pressure, and the generator water-cooling system, and if any one of these is abnormal, operation of the master relay is prevented and the generator will not start.

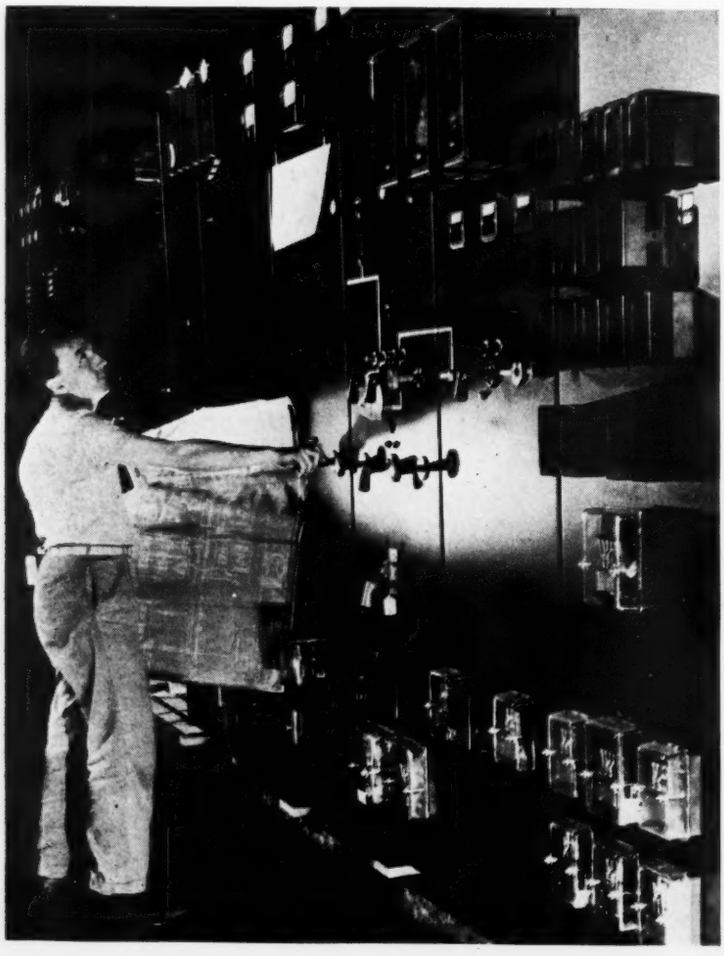
Trouble-detecting devices, by illuminating a sign telling which device is in trouble, and blowing a horn, warn the operator immediately if something goes wrong.

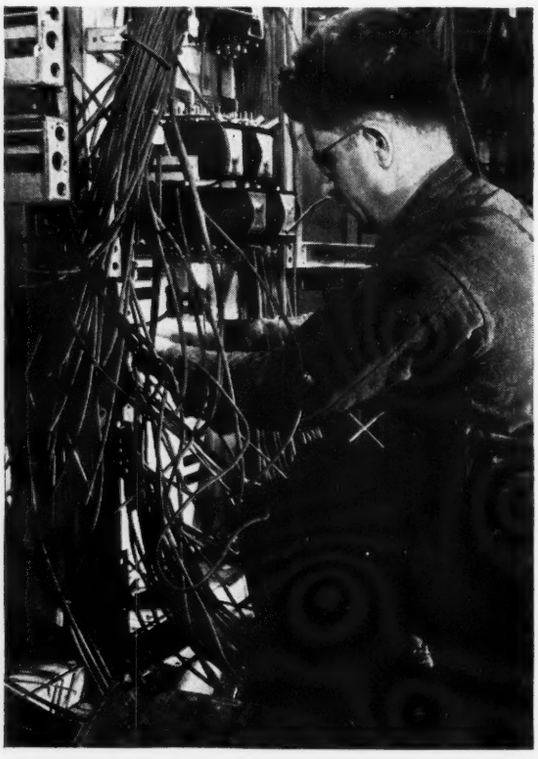
Coal Production Sets 10-Year Record

The following statement was released January 10 by John D Battle, executive secretary of the National Coal Association:

"The mine output of bituminous coal in the final quarter of 1940 reached 120 mil-

(*Continued on page 166*)





Left—Workman checks instruments on switchboard for one of two 82,500-kw waterwheel generators soon to be installed at Boulder Dam power house. This new Westinghouse switchboard carries instruments, control switches, and relays so arranged that the new unit can be stopped and started from the main control room in the same manner as the existing machines. Below—Wiring one of the switchboards

SHAW
PREFABRICATED
PIPING

Fabrication & Installation for **POWER & INDUSTRIAL PLANTS**

Serving Industry Since 1891

BENJ. F. SHAW COMPANY

2nd & Lombard Streets, Wilmington, Delaware

PIPING FABRICATORS AND CONTRACTORS

Don't Be a Sourpuss! . . .

MIDDLE-AGED JIM had just asked how to live for a long time.

Replied the Doctor: "Do you smoke?"

"No."

"Do you drink?"

"No."

"Do you gamble?"

"No."

"Do you run around with women?"

"No."

"Then what the Hell do you want to live a long time for?"

Most of us have at least some of Jim's share of the vices, so we don't have to worry about our old age on that score. But we may be forgetting something else that's more important—the building of a storehouse of happy memories to remember 20 or 30 years from now. One reason so many old men let their beards grow is because they're afraid if they take a good look at themselves in a shaving mirror they'll be tempted to cut their throats.

Old Sam Johnson, who certainly believed it, said once, "It is better to live rich than to die rich." He meant that lots of us keep putting off doing the things that are fun. A college professor just got through checking upon 3000 middle-aged people—and found that 94% are living in hopes of a brighter future and concentrating their whole present on winning it. Yet my pet insurance man tells me that only one out of each hundred 35-year-old men will be well off when he dies. That's pretty heavy odds, even though the Sunday-school teachers like the ant better than the grasshopper.

I know an aging man who doesn't know what to do with himself weekends—his job is his whole life. Another friend of mine was like that until he cracked up recently. He came out of it by planning—and building—a lakeside cottage. Now he hurries to get his work done so he can go fishing—and stay young at least in ideas.

So this is just a plea to you to relax once in a while. If you've wanted for years to ice skate again, this is a good year to start. If you've always wanted to play a guitar, start practising. Why, even if you want to write a book, you'd better be getting a pencil and paper. As the negroes say, "Time's a'wastin'!" Cecil Rhodes said it this way, "So little done—so much to do!" Don't be so busy earning a living that you forget how to live. That'll only lead you sure as shooting to the day when the boys start to calling you "Old Sourpuss"—and you begin to believe it yourself.

George Edwards
Engineer

The future is a world limited only by ourselves—MAETERLINCK

*An open message to Johns-Manville Employees**

by LEWIS H. BROWN, *President, Johns-Manville Corp.*

AS THIS NEW YEAR BEGINS, I am glad to have this opportunity to discuss with you the big job facing all of us during 1941.

Because of the demands placed on every business and every citizen by our nation's need for an adequate defense, our work is clearly cut out for us. We must contribute to the utmost of our ability to the defense building program.

Already, one-third of all J-M production is demanded for defense requirements. And this demand is growing daily. Some of it has been due to the increased need for J-M products for direct government projects. Some of it is the result of sales to expanding industries which use our products and are themselves working at top speed to fill government orders.

* * *

With every increased demand Johns-Manville has stepped up production to meet it. Many departments of our seventeen mines and plants have been affected by the defense needs and are now operating seven days a week, 24 hours a day. The working day is divided into three shifts of eight hours. At many locations, four shifts of employees work 40 hours each week to assure full production of the machines 7 days a week. Thus, work on Saturdays and Sundays is distributed fairly among everybody affected.

As the defense program develops we will necessarily have to step up our production more and more. This means we will have to find all the "bottlenecks" and increase the productivity of every machine.

Of course, most of us would prefer that industry's policy could be "business as usual." But these are not normal times. Business cannot be conducted "as usual" in an emergency. Defense comes first.

* * *

As a company, J-M is not going to let anything or anybody stand in the way of expediting the government's efforts to complete the defense program. This means co-operation by all of us, by management and by employees.

Naturally we shall all be called upon to make sacrifices. Taxes will be heavier. Raw material and manufacturing costs will probably rise. We shall all have to bear the burden.

Under these circumstances we shall have to redouble our efforts to reduce waste and increase efficiency so that we not only will be able to deliver quality goods in record time, but keep prices in check. By doing this we shall be helping to keep the costs of the defense program down. As taxpayers we shall indirectly benefit through this economy, for all of us must pay our share of the enormous defense bill.

* * *

There is no doubt in my mind that J-M jobholders can be relied upon to do their part. You have already shown the spirit of real co-operation and patriotism which is so necessary. For your co-operation I want to thank you.

I know that I can count upon your continued support and loyalty in our common effort to help keep this land of ours safe and free.

May I take this opportunity to wish for all of you health and happiness during this new year?

**Although not directly engaged in the manufacture of munitions or armaments, Johns-Manville manufactures many products essential to the operation of industries so engaged. This message, stating Johns-Manville's policy in support of the nation's defense program, originally appeared in the January, 1941, issue of the* News Pictorial, *J-M employee magazine.*

Pat'd. and Pat's. Pending

Cutout section shows Locking Ring in place

Get a GRIP on vibration

Save with UNSHAKO

Reg. U. S. Pat. Off.

Self-locking nut

It's always hazardous for nuts to work loose because it's essential that they stay tight. Play safe. Use "UNSHAKO" on all moving parts of Reciprocating Engines, Pumps, Conveyors, Generators, Stokers, etc. Its self-energizing locking ring "springs to life" and grips the bolt or stud whenever there's a backing off tendency and thereby insures permanent tightness. Of course, the "Unshako" can be removed with a wrench and used over and over again without the slightest loss of efficiency. Write for complete details.

STANDARD PRESSED STEEL CO.

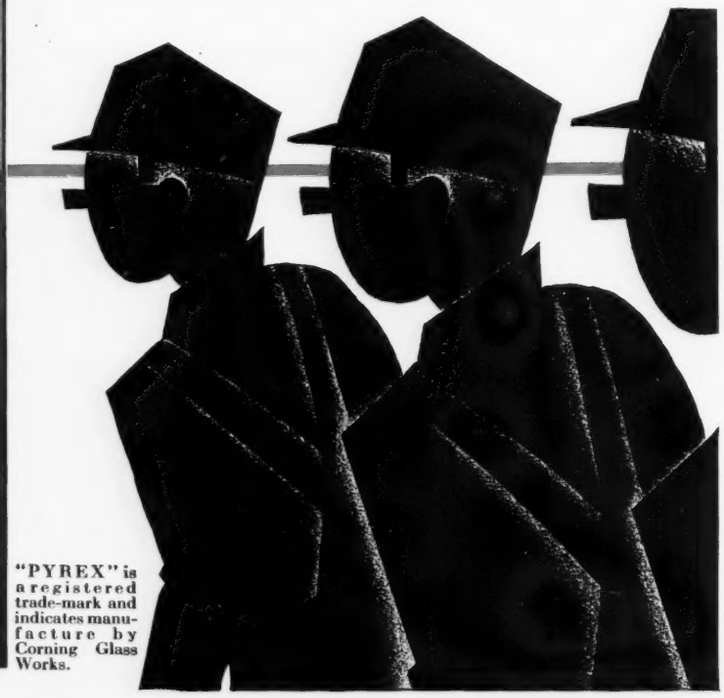
BOX 577 JENKINTOWN, PENNA.

Visibility

FROM ANY DISTANCE

Look at the illustration at the left. Here is a reproduction of a "PYREX" Broad Red Line Gauge Glass as you would see it in your boiler room from directly in front. Hold this picture at arm's length; you can't deny its visibility. Place it across the room, fifty, even a hundred feet away. As long as you can see it, you can see the liquid level.

The transparent red line of a "PYREX" Broad Red Line Gauge Glass is fused permanently into the wall of the gauge glass, combining unmatched visibility with the resistant qualities of a "PYREX" Gauge Glass. At all leading mill and steam supply dealers.



"PYREX" is a registered trade-mark and indicates manufacture by Corning Glass Works.

CORNING Glass Works Corning, New York

Pyrex Gauge Glasses

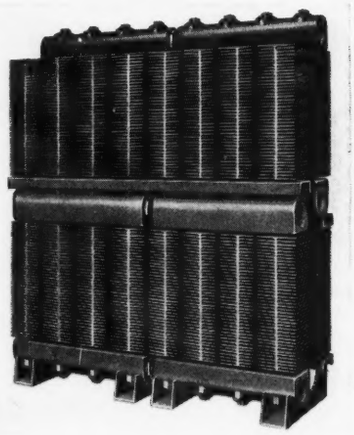
New Plant Equipment

(*Continued from page 132*)

mits re-greasing. Pre-lubrication and ability of bearing to retain lubricant reduce maintenance. Bearing is fitted with snap-ring as standard equipment against bearing location. This permits through bore in housing, eliminating counter boring to shoulder. While knurled, cup-point set-screws are furnished as standard equipment, one-half dog-point set-screws with lock wire can be furnished instead at no increase in cost. *Stephens-Adamson Mfg Co, 5 Ridgeway Ave, Aurora, Ill.*

Condensers

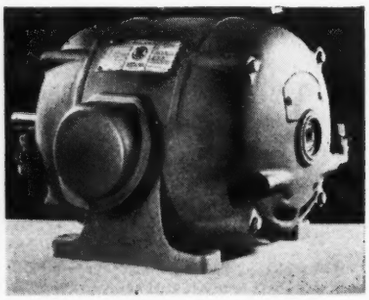
"GRID" CONDENSERS can be installed in window spaces or in walls, without taking up floor space. Units are immune to atmospheric corrosion resulting from contamination of the air from sulphur and sulphides and other products of combustion. No



electrolysis can develop in them, as supply and return lines, and steam chamber are of one type metal. Heating sections of condensers are easy to keep clean, as it has no tortuous air-steam passages to get clogged. Units are guaranteed for 250 lb steam pressure, continuous operation. *D J Murray Mfg Co, Wausau, Wis.*

Induction Motors

OPEN-TYPE, SLEEVE-BEARING SQUIRREL-CAGE MOTORS are designed specially for general-purpose drive applications such as pumps, auxiliary drives and others. Rigid complete-cast frames maintain constant air-



A SINGLE ANSWER...

to Your Power Plant Valve Requirements

When it's a question of gate, globe, check or angle valves . . . for manual or motor operation on pressures up to 2500 lb. and temperatures to 1000°F . . . there's one good answer to *all* your requirements: CHAPMAN.

Moreover, all of these valves are available in metals that are poured and tested under the supervision of Chapman metallurgists, in the Chapman foundries—insuring most satisfactory performance on all specific applications.

Standardize on CHAPMAN Power Plant Valves Bring every valve in your plant up to the performance work guaranteed by Chapman precision workmanship. Our catalog gives complete specifications. Write for it.

AVAILABLE IN THESE ALLOYS

Carbon Steel—Carbon Molybdenum Steel—Chrome Nickle Steel—Chrome Molybdenum Steel—Nickle Steel—all poured into castings under the direct supervision of Chapman metallurgists, *right in Chapman's own foundry.*

The Chapman Valve Mfg. Co., Indian Orchard, Mass.

CHAPMAN

POWER PLANT VALVES

Two Schramm Direct Drive "UTILITY" Compressors installed on roof of inside room in press and forge plant supplying air for hand tools, platform hoist and blowing mill scale off hot steel.

HERE'S THE EFFICIENT, ECONOMICAL WAY TO PROVIDE COMPRESSED AIR SERVICE

Your need for compressed air for whatever purpose can be supplied at minimum costs for power, maintenance and attendance by Schramm "Utility" Stationary Air Compressors.

These self-contained, compact, modern units—the result of 40 years' continuous development and service-proved under the most severe conditions—are vibration free and can be installed in any convenient location. Costly foundations are unnecessary. Ability to place a Schramm Compressor close to the point where compressed air is required results in substantial savings in piping and assures delivery of air where needed at maximum pressure.

It will pay you to explore the possibilities of providing air where you need it with Schramm Compressors. Schramm can supply your requirements promptly. Investigate today.

Condensed Specifications and Features

Cylinders—Vertical; cast en bloc. **Valves**—Camshaft operated intake, perfectly timed for maximum efficiency; discharge valves of generous size. **Balance**—Assured by multiple cylinder construction and light weight reciprocating parts. **Control**—Positive and automatic by simple pilot valve integral with intake valve lifting mechanism. **Lubrication**—Force feed to all compressor bearings and moving parts. **Sizes**—Made in *piston displacement capacities* from 25 to 600 cu. ft. per min. **Drive**—Motor, V-Belt or Direct Drive. Send for Bulletin No. 3907 giving details of sizes, features and types.

SCHRAMM, INC., WEST CHESTER, PA.

SCHRAMM UTILITY STATIONARY AIR COMPRESSORS

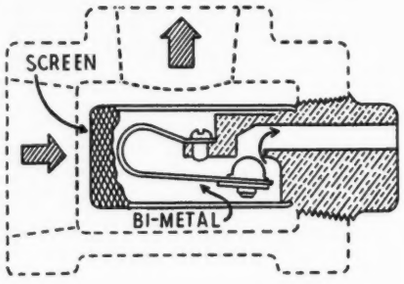
gap between stator and rotor, and frame improvements include new sealed sleeve-bearings having combination vestibule and felt-washer-seal, and larger oil-reservoir capacity. Available in ratings from ½ to 5 hp, at speeds from 875 to 3600 rpm, for operation on 110, 220, 440, and 550 volts, 2- and 3-phase, ac. *Westinghouse Electric & Mfg Co, East Pittsburgh, Pa.*

Lamp Starter

MIRASTAT fluorescent-lamp-starter available for use with lamps from 15 to 100 watts. Improvements claimed for patented starter include elimination of "sputtering", due to proper preheating of lamp cathodes; retardment of lamp-blackening; longer lamp life; and definite, accurately-timed starting and re-starting. Wattage consumed by starter is approximately ½ watt. Starter operates with fluorescent lamps on either direct or alternating current, and starter circuit includes condenser designed to minimize radio interference. Compensation is made for temperature, so that starter operates satisfactorily over wide range of surrounding temperatures. Mirastat is also interchangeable with glow-relay types of starters, using same type socket. *Hygrade Sylvania Corp, Salem, Mass.*

Thermo Drain

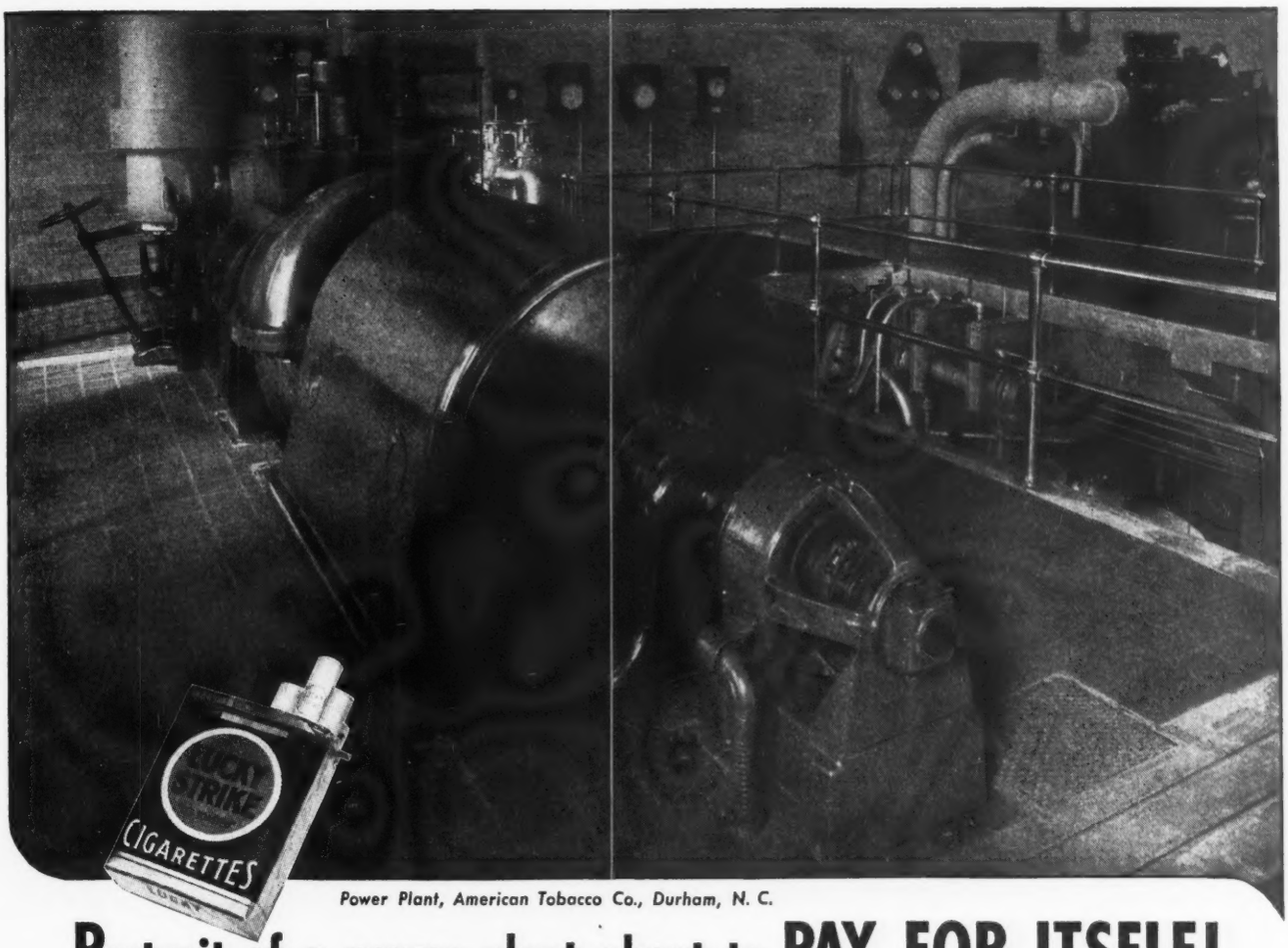
IMPROVED THERMO DRAIN prevents freezing in steam traps when they are outside. When steam is kept on all the time, there is no need for unit, but when steam is turned on and off unit will provide for automatic drainage of prime from trap-body. Any interruption in steam-supply will drop



temperature and cause thermic element to bend and pull ball-valve away from seat, allowing condensate in line to drain to ground. When steam is again turned on, rising temperature flexes thermic element in opposite direction, closing valve. Thus condensate must pass up through trap in usual manner. *Armstrong Machine Works, Three Rivers, Mich.*

Lubricating Oil

SAVAMOTOR "All Season" motor oil is manufactured in all SAE grades for internal-combustion engines, stationary, automotive or in airplanes. Specifications of given sample as follows: viscosity index 100+; gravity less M, 28; microphites by weight, 1%; flash 430 F; viscosity at 210 F, 67 sec; carbon 0.39%; cold test 0 F. Claims made include: 5000 miles between



Power Plant, American Tobacco Co., Durham, N. C.

Portrait of a power plant about to PAY FOR ITSELF!

Thanks to efficient, economical COAL, the enlarged plant of the *American Tobacco Company* at Durham, N. C. will repay its cost in a few years. In the past this company used dependable, *clean*-burning coal for process steam and part of its power. Decision to increase steam capacity and generate all power meant an investment in new boiler and stoker, turbine generator, new coal bunker and conveyor. But, with coal doing the whole job right in the plant, this equipment will write off its cost in a few years. Unusual? Quite the contrary! The economies of modern, prepared coal are making such savings possible today in modern, wide-awake plants all over the country.

LET OUR FUEL SERVICE ENGINEERS LOOK FOR SIMILAR SAVINGS IN YOUR PLANT

Since it won't cost you a dime to find out, why don't you investigate possible economies in your own plant? Many a company today thanks Chesapeake and Ohio for plans that are paying back big dividends in savings on steam, fuel and maintenance costs. If you'd like our engineers to survey your plant, confer with your engineers and make cost-cutting suggestions — no obligation — just write GEORGE H. REINBRECHT, Coal Traffic Manager, Chesapeake and Ohio, 2901, Terminal Tower, Cleveland, Ohio.

IT PAY$ TO U$E MODERN ...

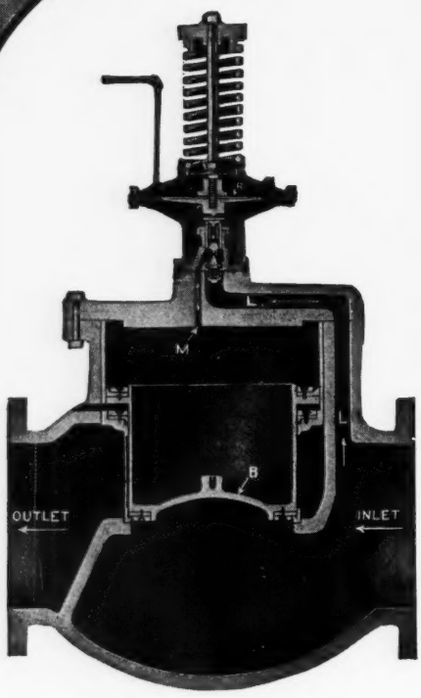
Chesapeake and Ohio Lines

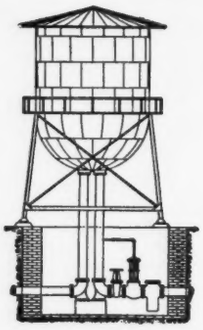
ADVERTISING PAGES REMOVED

GOLDEN-ANDERSON

Specialty

VALVES





ALTITUDE CONTROL

• Hold efficiency at an even level by equipping your tank or standpipe with G-A Altitude control valves. You'll get a constant, automatic water level at all times, with no overflow. This valve is positive in action, with no water or hammer shock. Comes in sizes of 2" to 36", in either globe or angle pattern. Air and water cushioned, it also includes full bronze trim with no metal contacts. Write for your free copy of the G-A catalog . . . it completely describes the entire line.

also

Emergency Throttle . . . Float Control . . . Pressure Reducing . . . Triple Acting Non-return . . . Check Valves . . . Etc.

Golden-Anderson Valve Specialty Co.

Fulton Bldg. • • • Pittsburgh, Pa.

changes, with normal level of oil; no motor damage starting cold with any SAE rating of oil; all engines will run for longer periods without overhaul; engine speeds increase 5 to 10% at full throttle. *Sava Co, 140 Liberty St, New York, N. Y.*

Fibre Pulleys

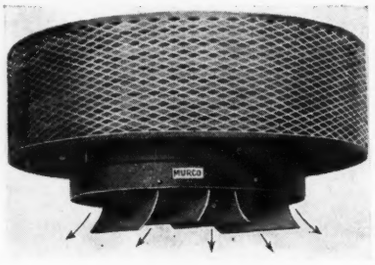
NEW CONSTRUCTION for small and medium-sized rolls or pulleys provides tough rugged hub and spider of zinc alloys, stronger than iron, cast under high pressure right into body of fibre. Maker claims that using fibre pulleys, instead of metal or wood, improves machine performance. *Rockwood Mfg Co, Indianapolis, Ind.*

Firebrick

IRONTON CAVALIER is intermediate-heat-duty fire brick, made from selected semi-plastic clays. Give successful service in hand-fired boilers, brick kilns, annealing ovens, waste-heat installations, and as back-up brick in super boiler settings. Because of its strength, brick has high salvage value. *Ironton Fire Brick Co, Ironton, Ohio*

Unit Heaters

VERTICAL PROJECTION-TYPE HEATERS are addition to line previously manufactured. New units made with heating elements



all-copper and bronze, with few brazed joints. Copper fins are metallically bonded to copper tubes with a permanent bond that maintains contact of high temperatures. *D J Murray Mfg Co, Wausau, Wis.*

Welding Electrode

MUREX ALTERNEX is addition to line of covered electrodes made by company. New electrode is designed for use with transformer-type ac welding equipment, and handles well in all positions, including "vertical-down-welding". In smaller sizes it can be used in welding light-gage steel. *Metal & Thermit Corp, 120 Broadway, New York, N. Y.*

Gage Tester

MSA VELOCITY POWER GAGE-TESTER is device for safety-testing gages used in conjunction with compressed-gas storage cylinders, to determine their ability to with-

(*Continued on page 146*)

"Mike" Speed of Eagle-Globe-Royal Indemnity Co. and Herman Dost, Chief Electrician of Pennsylvania Sugar Co., on a periodic "sleuthing expedition" to detect faulty insulation . . . they keep Pennsylvania Sugar's big generators running.

Quick, Watson, The "MEGGER" Tester

"Every Saturday before and after our week-end cleaning, the 'Wizard' (that's what we call Herman Dost) applies our 'Megger' Tester to all of our important generating equipment. Usually nothing happens, except that some figures are added to our records of insulation resistance.

Then one day the 'Megger' test indicates that somewhere there's a leak. Maybe an innocent wire has rubbed against a jittery frame and, like the surgeon's X-ray, the 'Megger' test detects the condition and a failure is forestalled.

With our insulation resistance records, we further watch any progressive weakening of the 'arteries' and have warning that permits us to make repairs at convenient times, rather than tie up all or part of our plant. Newly wound motors and wiring installations also have to submit to the 'Megger' test and not infrequently a blow-up is thereby averted.

A maintenance gang without a 'Megger' Tester would be like a hospital without an X-ray machine."

DAN GUTLEBEN,
Chief Engineer at the Pennsylvania Sugar Company's Philadelphia Refinery.

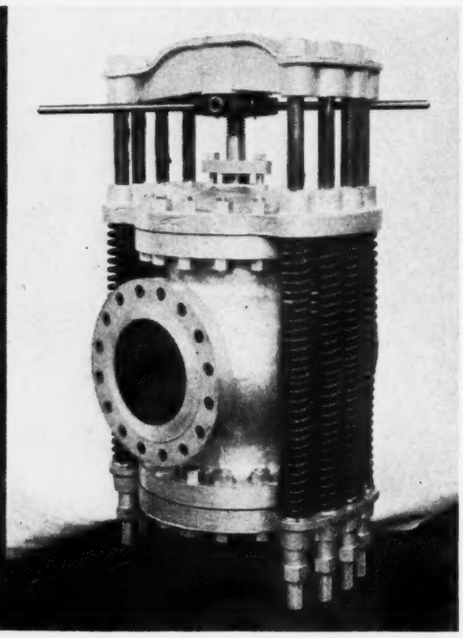
"MEGGER"
Trade Mark
Reg. U. S. Pat. Off.

Any one with an equal determination to forestall trouble can match this splendid record and enjoy similar freedom from power failure and unnecessary repair bills. Write for Bulletin 1655-P on Getting Results with "Megger" Insulation Testers.

JAMES G. BIDDLE CO.
1211-13 ARCH STREET *Electrical and Scientific Instruments* **PHILADELPHIA, PA.**

MAXIMUM TURBINE PROTECTION

with
DAVIS NO. 265 TURBINE BLEEDER RELIEF VALVES



- ***SENSITIVE CONTROL!*** — Multiple spring loading provides fast, accurate, pressure relief at valve setting, with much less spring load accumulation than in single spring-loaded types. From 2 to 12 batteries of springs are used, depending on size of valve and pressure at which it is to relieve.
- ***LARGE PORT OPENING!*** — Full port opening of large valve disc gives lower steam velocities, smoother flow. One Davis No. 265 can often replace several smaller "pop" safety valves.
- ***FULL RANGE OF SIZES!*** — All pressures—from 5 to 200 lbs. can be handled by Valves ranging from 4 inches to 30 inches in size. One large power plant has seven No. 265 valves on bleeder lines at various turbine stages!
- ***SAFETY!*** — Multiple spring loading, non-sticking valve, large capacity, rugged construction—all give Davis No. 265's a greater margin of safety in protecting turbines: all add up to extra years of trouble-free service from turbines so protected.

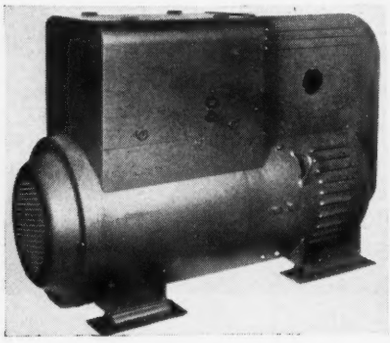
Write today for complete data on the Davis Line of valve specialties. Over sixty years of specialized experience stands behind Davis engineers—ready to help you solve your individual plant problem. DAVIS REGULATOR CO., 2540 S. Washtenaw Ave., Chicago, Ill.

DAVIS REGULATOR COMPANY

stand sudden applications of surge pressure encountered under service conditions. Gage to be tested is assembled in position under transparent guard, which permits visual observation of test and as protection to operator in case gage fails during test. Small blank cartridge is inserted in breech-unit of tester and manually discharged by means of spring-actuated firing-pin. Pressures resulting from cartridge-discharge are transmitted directly to gage mechanism, causing it to function in normal manner under high initial load. Signal light indicates gage has been subjected to required test pressure. *Mine Safety Appliances Co, Pittsburgh, Pa.*

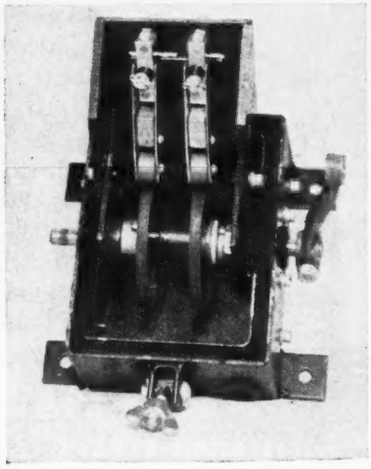
Speed Controls

ADDITIONAL V-S SPEED UNITS announced, with 20, 25 and 30 hp. Same principle of speed-control is used as on other sizes. Only changes made are concerned with outward appearance. For sake of compactness, unit has been mounted horizontally instead of vertically, and particular attention has been given to design of mounting brackets. These contain special longitudinal rubber shock-pads to insure quiet operation of unit. *Reliance Electric & Engrg Co, Ivanhoe Rd, Cleveland, Ohio.*

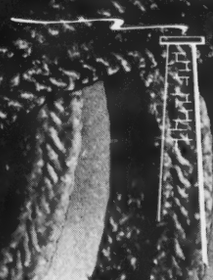


Cam Limit Switch

CAM-OPERATED LIMIT SWITCH is made with contacts arranged to swing open for inspection and maintenance, and is designed specifically for control-circuits of such devices as hoists, industrial trucks, etc. Limit



RECORD *breaking* IS A *John* CRANE *custom*



Case Record

3 YEARS OF **VALVE STEM** HEAVY DUTY WITHOUT GLAND ADJUSTMENTS! . . .

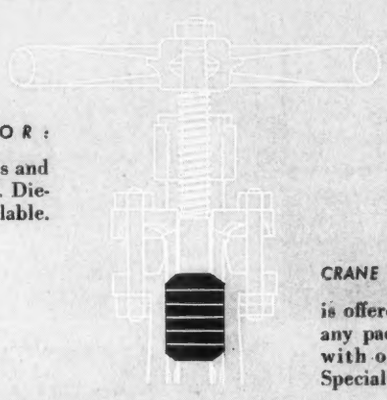
Industrial Service; Pressure: 660 lbs. Temperature: 750° F.

REASON?

PLUS-*PAK*...

That Patented, Exclusive Xxtra Which *Lasts Twice As Long!*

John CRANE *Style* 6AM *Super-heat* STEAM PACKING



RECOMMENDED FOR:

pressures up to 1200 pounds and temperatures up to 900° F. Die-formed rings and sets available.

. . . . . Crane packing records are so successive, as to appear as everyday performance . . . John Crane has become known as the select packing, because of the winning qualities inherent in pre-tested ingredients, expertly assembled and tailored to exacting needs, and because of PLUS-PAK—that exclusive refinement which is a plus-value of Crane.

CRANE PROBLEM COUNSEL . . .

is offered without obligation on any packing condition. Consult with our engineering staff on Special Packings.

CRANE PACKING COMPANY, Chicago, U.S.A. P-241
CRANE PACKING COMPANY, Limited, Hamilton, Ontario, Canada

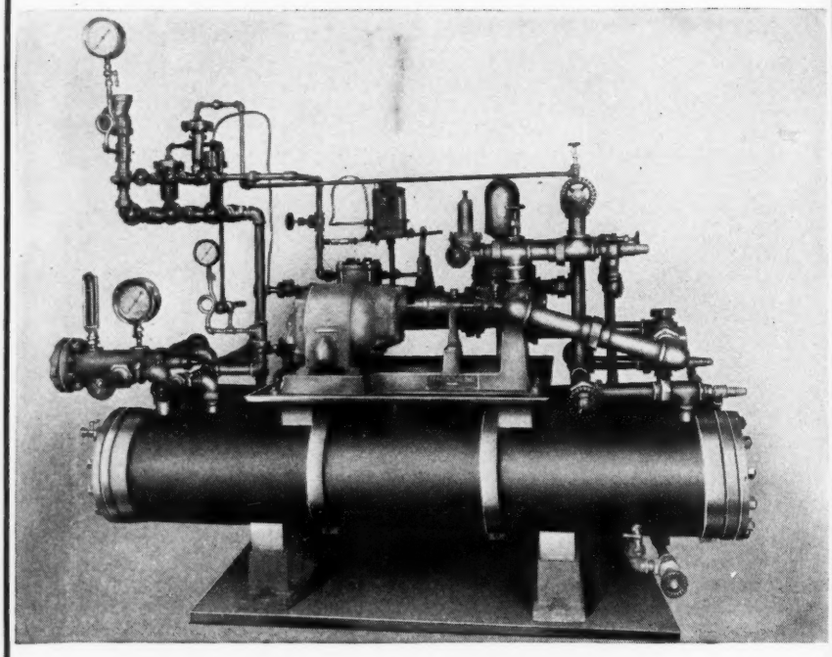
NAME_____ TITLE_____

ADDRESS_____ COMPANY_____

CITY OR TOWN_____ STATE_____

Enco

FUEL OIL PUMPING *and* HEATING SYSTEMS



CAPACITIES

from 100 to 5000 gallons per hour

Pumping unit systems are designed for heavy bunker oil or light furnace oil.

Single or duplicate pumps and heaters are used, each of full capacity. These are interconnected so that operation is obtained with any combination of pump and heater.

The pump may be either the steam driven duplex or the rotary or screw type driven by motor or turbine.

Heaters are of the steel shell straight tube type, insulated and jacketed with planished steel.

Fully automatic control of oil pressure and temperature with relief valves for each pump and heater—This permits the delivery of the oil with safety and at the proper temperature and pressure for efficient burning.

Complete piping so arranged that operation is obtained with any combination of pumps and heaters. Any part can be cut out of operation for inspection or cleaning.

Each unit is delivered completely built and ready to place on foundation and for connection to the station piping.

Write for Bulletin OB-40 describing Enco Oil Burning, Pumping and Heating Equipment.

THE ENGINEER COMPANY

75 West St., New York, N. Y.

switch is available with ratings of 2 amp at 600 volts dc and 25 amp at 110 volts ac. It has two contacts, either or both of which may be normally open or closed. Special feature of new switch is Micarta fingerboard on which contacts are mounted. Operation of switch is by means of a cam-shaft on which rollers travel. These rollers make or break contacts at any point on travel. Switch may be operated by either a revolving shaft coupled to its cam-shaft, or by movement of an operating lever attached to cam-shaft. Moving contacts are self-aligning, with a compensating-type operating-finger. *Westinghouse Electric & Mfg Co, East Pittsburgh, Pa.*

Carry-Over Alarm

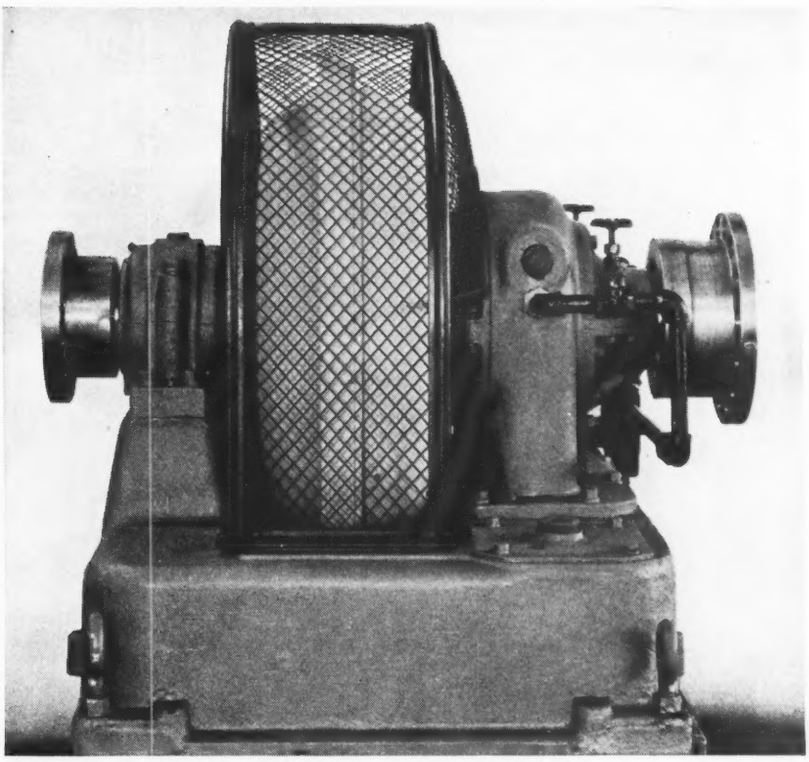
SOLU-BRIDGE controller gives automatic warning of presence of excessive carry-over in boiler condensate by flashing lamp, ringing bell or recording on meter. In installation, small steam pipe is brought from boiler header to simple condenser. Condensate is passed through a vertical pipe which has conductivity cell screwed in bottom. Cell is wired to Solu-Bridge controller (which may be at some distance, to be handy to boiler-room crew). Alongside instrument is warning means of recording instrument. Both analytical and control functions are handled by same instrument. One dial is set at approximately condensate temperature, if accurate percentage readings are required. Main dial-knob is then turned until indicator, observed through hooded peep-hole, presents widest angle of dark segment. Percentage of carryover present in condensate is now read directly off dial. Setting of temperature-knob is not critical for warning purposes, and may be left at approximately condensate temperature. It may be as much as 10 deg off actual condensate temperature, yet accuracy of percentage reading or warning will not be off more than 0.3 parts per million, plus or minus, at a reading of 3 ppm. *Industrial Instruments, Inc, Jersey City, N. J.*

Thermostat

HEAVY-DUTY THERMOSTAT comprises thermostatic element suitable for electric-heater loads of 1500 watts at 115-230 volts ac. Thermostatic element is mounted on removable cover, giving greater accessibility and easier wiring. Available in temperature ranges of 300, 450, and 700 F. *George Ulanet Co, Newark, N. J.*

Non-Inflammable Transformer

"NOFLAMOL" transformer is filled with non-inflammable synthetic liquid developed recently. Maker states that because of non-inflammable characteristics of this liquid, transformer can be installed indoors without fireproof vaults. *Wagner Electric Corp, 6400 Plymouth Ave, St. Louis, Mo.*



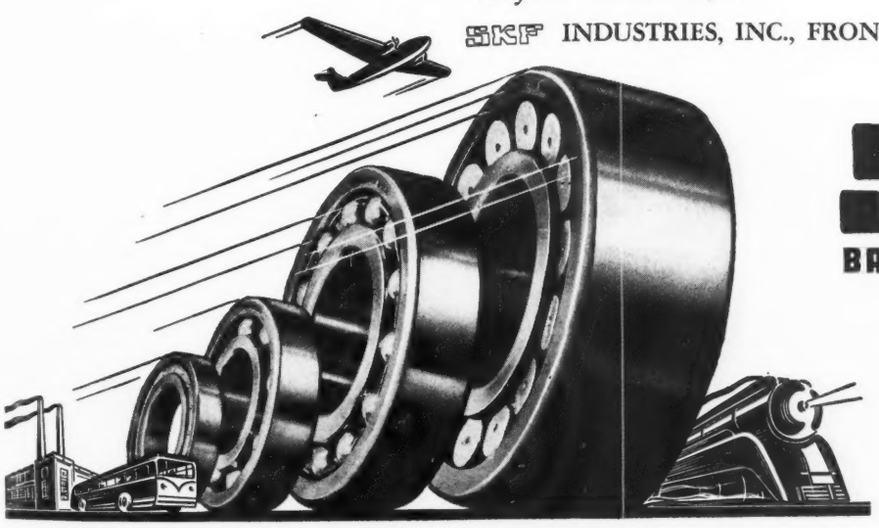
BUILT BY HYDRAULIC COUPLING DIVISION, AMERICAN BLOWER CORP.

On Hydraulic Couplings

BEARINGS CAN'T SHIRK

IF you prowl around inside this Hydraulic Coupling, it won't take long to learn why it operates so smoothly. Between driving motor and impeller, you'll find a fixed SKF Self-Aligning Spherical Bearing taking thrust. On the driven shaft, you'll find an SKF Deep-Groove Ball Bearing also taking thrust . . . and an SKF Cylindrical Bearing carrying radial loads—permitting free axial expansion. You'll realize, then, that SKF can put the right bearing in the right place on *your* machines, too.

SKF INDUSTRIES, INC., FRONT ST. & ERIE AVE., PHILA., PA. 4729



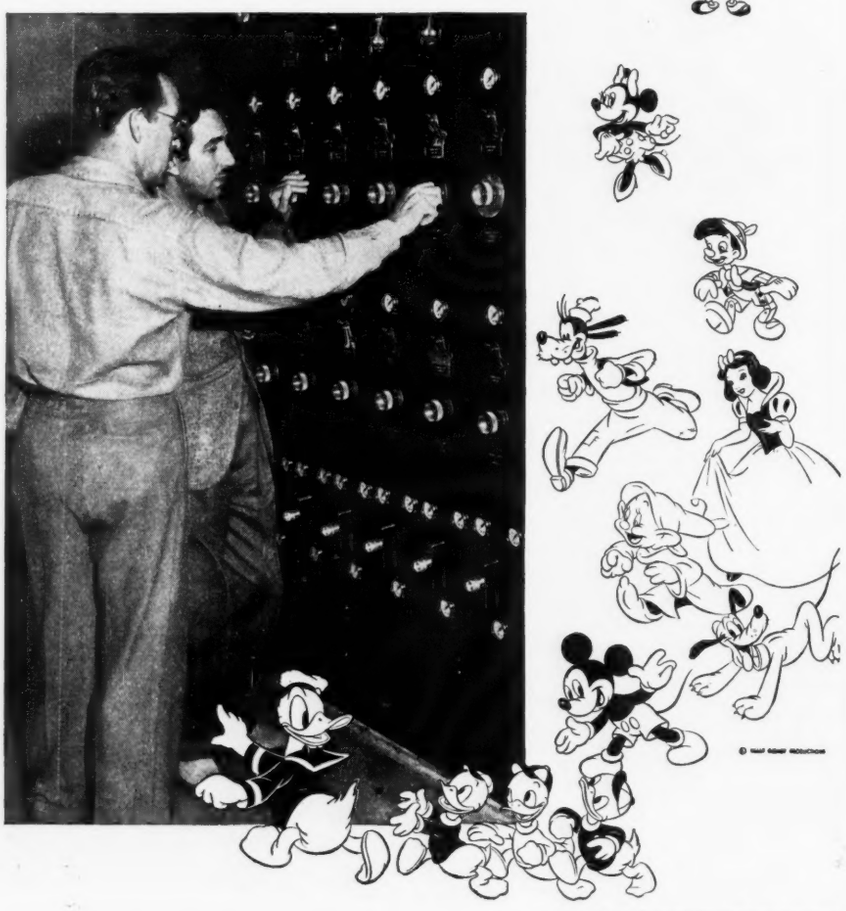
SKF

BALL & ROLLER BEARINGS

Air Conditioning in Walt Disney Studios...

Comprehensive Temperature Control

by JOHNSON



Johnson worked for months, installing automatic temperature and air conditioning control equipment in the new buildings for Walt Disney Productions, Burbank, California. Hundreds of thermostats, valves, dampers, and damper motors were assigned to the important job of maintaining correct conditions in the various rooms in this great group of buildings. Many of the smaller buildings and projection rooms are incased completely in sound-proof walls, insuring complete elimination of noise... In the larger buildings, distribution of air is influenced by the type of occupancy. Ingenious control apparatus insures accurate temperatures and humidities . . . How important is the WHOLE SYSTEM! How important, too, is the *complete service* offered by Johnson! ASK FOR BULLETINS describing Johnson automatic control for air conditioning.

Upper left: Walt Disney (right) and Chief Engineer William E. Garity inspect the Johnson central control panel in the Camera Building. *Above:* Johnson valves on hot water heating mains in the Central Heating Plant.

JOHNSON

Automatic TEMPERATURE AND AIR CONDITIONING Control

JOHNSON SERVICE COMPANY, MILWAUKEE, WIS. & BRANCHES IN PRINCIPAL CITIES

Reader's Problems

(*Continued from page 111*)

ash from a typical stack is shown in the table, with particle size varying from 840 microns down to 0 micron. One micron, designated μ, equals about 1/25,000 in. It can be seen that about 80% falls in the size range 149μ and larger. Particles of a minimum size of 150μ may then be used as a basis for design of a dust collector.

Any horizontal run of duct or breeching, such as that shown in the second sketch, will act as a flyash collector if it is provided with hoppers for continuous or intermittent removal of the separated flyash. Design should allow sufficient time for removal of smallest particles (about 150 as mentioned above) and should be wide and low rather than high and narrow. Chains or wires to minimize eddies are desirable; they also tend to collect the finer dust by direct contact.

A horizontal run of duct or breeching may be made into another type of collector by installing baffles (see sketch). The distance the dust particles must move to get out of the gas stream is seldom less than 3 ft and the angular distance is ordinarily π radians, or 180 deg per pass. There may be one or more passes depending on the efficiency of separation desired. The baffles are sometimes coated with oil or similar dust-retaining fluid, to improve efficiency of separation and prevent redispersion of the particles.

When the duct or breeching can be provided with a fan as shown in the sketch the flyash will concentrate toward the outer wall due to centrifugal force. This outer stratum of flue gas, containing most of the flyash, is removed from the main stream and the entrained flyash removed in an auxiliary piece of equipment. The ordinary cyclone shown in the sketch is similar to the centrifugal concentrator except, unlike the cinder fan, the ash particle may make several revolutions before separating out of the gas stream. The above types of flyash collectors, with the exception of cinder fans, can be designed by the plant engineer and built on the job to suit the particular physical and operating conditions of the plant.

Harmon-on-Hudson, N. Y. R L JULSRUD

Bur. of Stds. Sieves		*Part. Size Microns*	*% by weight*
on	20-mesh	840	10
	40	420	20
	60	250	25
	80	177	15
	100	149	11
	200	74	8
	325	44	6
through	325	0	5

SUGGESTIONS FOR SPECIFICATION FOR STANDARD DIAL CONSTANTS FOR ALTERNATING-CURRENT WATTHOUR METERS. *Published by Edison Electric Institute, 420 Lexington Ave., New York, N. Y. 4 pages, price $.10.*— Suggestions are intended to be used by member companies as an aid in preparing their own specifications for purchase and use of this equipment.

40% LESS STRESS WITH 38% SAVING IN SPACE

in this PITTSBURGH PIPING CREASED and CORRUGATED PIPING

40% LESS STRESS

Calculations based on using a plain expansion bend 20' wide and 13' high show a maximum bending stress of 14800 lbs. per square inch which is excessive. By using Pittsburgh Piping creased and corrugated construction bending stress is reduced to 8000 lbs. per square inch and resultant end reaction drops from 3200 lbs. to 1400 lbs.

38% SAVING IN SPACE

If a plain expansion bend 20' wide were employed in this assembly, it would be necessary to increase the overall height from 13' to 21' to maintain the same bending stress of 8000 lbs. per square inch obtained with the creased and corrugated construction; a saving in space of 38%.

10" Creased and Corrugated Expansion Bend
13 Ft. High 20 Ft. Wide

Pittsburgh Piping

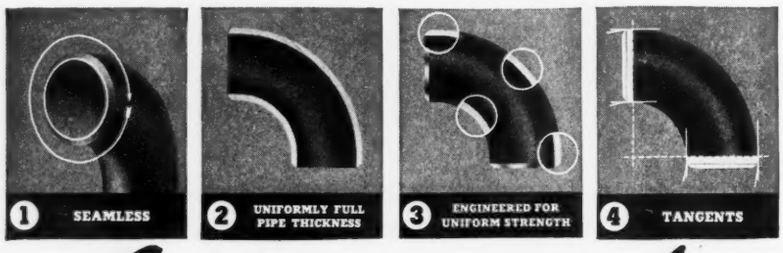
CREASED BENDS WITH CORRUGATED TANGENTS

From the comparisons made in the above panels, you can readily see how Pittsburgh Piping Creased Bends and Corrugated Tangents make possible unusual compactness in the design of any piping system. They are particularly valuable when replacing existing piping systems with more complex, high temperature piping in the same building. For complete data about the extraordinary flexibility of this type of piping, write for your copy of "Pittsburgh Piping Design Manual."

PITTSBURGH PIPING & EQUIPMENT CO.
10 FORTY-THIRD STREET PITTSBURGH, PA.

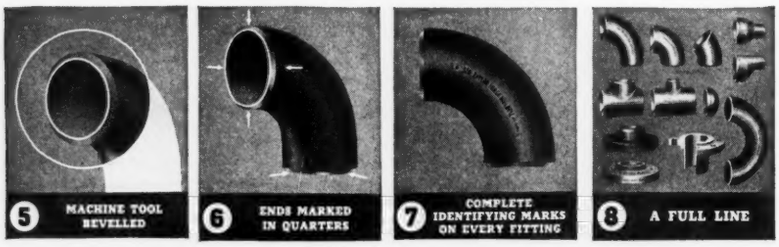
Woolworth Bldg., New York Occidental Bldg., Indianapolis Peoples Gas Bldg., Chicago Union Guardian Bldg., Detroit
Public Sq. Bldg., Cleveland 10 High St., Boston Liberty Life Bldg., Charlotte 525 Market St., San Francisco

TAYLOR FORGE



On your next job

make the acquaintance of the only welding fittings that offer you all these 8 aids to faster, easier welding



WeldELLS

Seamless Pipe Fittings for Welding

TAYLOR FORGE & PIPE WORKS

General Offices and Works: Chicago, P. O. Box 485
New York Office: 50 Church St.
Philadelphia Office: Broad Street Station Bldg.

OBITUARIES

FRED R DAVIS, assistant advertising manager of General Electric Co, died on Dec 27, 1940. He was in charge of Media and Publisher's relations for the company for several years, as well as holding the advertising position. He was one of the founders of the Audit Bureau of Circulations, and was active in the work of the bureau throughout his lifetime.

BRUCE W DEACON, for eleven years Detroit manager of D A Stuart Oil Co, died on Dec 9, 1940, after an illness of several weeks. He was 57 years old. As one of the oldest industrial oil salesmen in Detroit, he enjoyed the contacts of numerous Detroit factory and purchasing officials.

PROF JOHN G GALLAN, of the Harvard School of Business Administration, died in Cambridge, Mass., on Dec 31, 1940, following a heart attack. He was widely known as an authority on steam turbines and held over 70 patents in the prime-mover field. He joined the staff at Harvard in 1919 and at the time of his death was professor of industrial management.

JAMES A MAGUIRE, 68, for over 20 years chief engineer at the Newton, Mass., city hall, died at his home in that city Dec 26, 1940, after an illness. He was a native of Ireland, and had been employed by the city for about 30 years.

GEORGE T SMITH, 85, president of the Joseph Dixon Crucible Co since 1908, died at his home in Jersey City, N. J., on Dec 20, 1940, after a brief illness. He joined the Crucible company following service with the United States Shipping Board. At the time of his death, in addition to holding the presidency of the Joseph Dixon Crucible Co, Mr Smith was president of the American Graphite Co, vice-president of the Colonial Life Insurance Co of America, and vice-president of the Raritan River Railroad in New Jersey.

PIERCE J KENT, retired chief system operator of Boston Edison Co, and past chairman of the New England System Operator's Club, died recently. He was a graduate of Phillips Exeter Academy, and starting with the Boston Electric Light Co, which was later absorbed by the Edison Co, rose to become electrical division head in charge of L Street and Edgar Stations, and a large group of substations.

DUREZ the modern plastic selects the COCHRANE SOFTENER

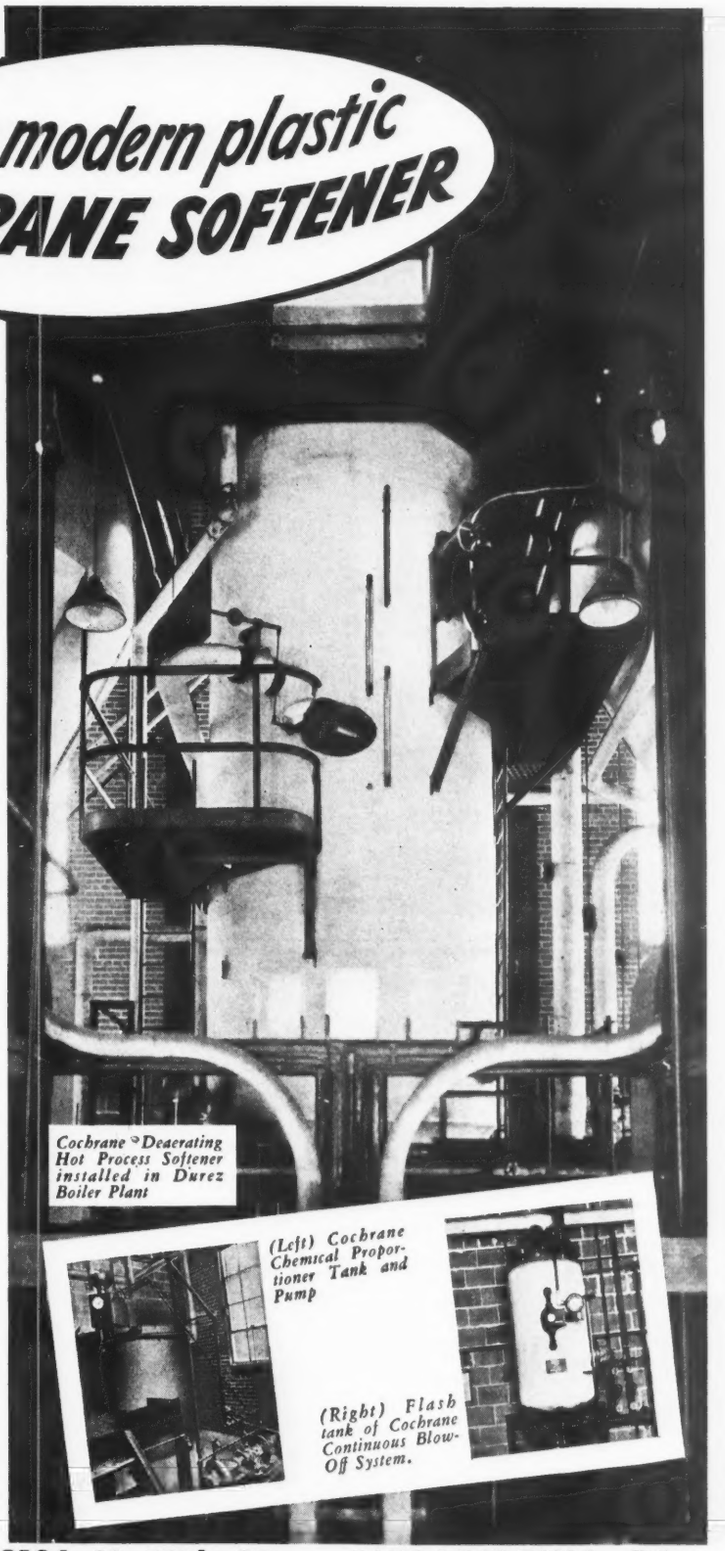
for the model boiler plant of the ultra-modern Durez factory at North Tonawanda, N.Y.

New steam plant for Durez Plastics & Chemicals, Inc., N. Tonawanda, N.Y.

AT North Tonawanda, N.Y., the fast-growing business of Durez Plastics & Chemicals, Inc., necessitated the building of a new synthetic phenol plant, which includes a separate building housing the steam plant which furnishes process steam and power.

For feedwater treatment supplying the two 45,000 lb./hr. 2-drum boilers, a Cochrane Deaerating Hot Process Softener was installed. The plant has been in operation since February, 1940, and this feedwater treatment has yielded highly satisfactory results. A Cochrane Continuous Blow-Off System is also a part of this boiler plant, adding the proven economies of continuous boiler blowdown to the many other "planned efficiencies" of this model plant.

Publications describing the type of equipment installed at Durez will be mailed upon request.



Cochrane Deaerating Hot Process Softener installed in Durez Boiler Plant

(Left) Cochrane Chemical Proportioner Tank and Pump

(Right) Flash tank of Cochrane Continuous Blow-Off System.

COCHRANE CORPORATION • 3106 N. 17th ST. • PHILADELPHIA, PA.

COCHRANE

WATER SOFTENERS • DEAERATING HEATERS • DEAERATORS • BLOW-OFF EQUIPMENT • VALVES • FLOW METERS

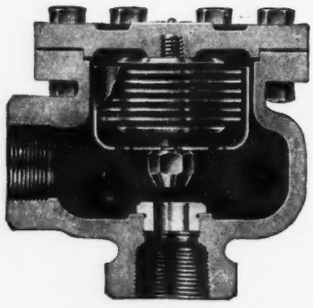
NICHOLSON

CONTROL VALVES FOR LONG, PRESSURE-TIGHT SERVICE

Available in TWO, THREE, FOUR-WAY and Special Types for operating Air, Steam, Water or Oil Cylinders on pressures up to 300 lbs. Made in five different metal combinations to cover all mediums handled. Non-corrosive metals are used in all vital parts. Gaskets and gland packing, suitable for each specific service are used.

Nicholson also offers foot, solenoid and motor operated valves and valves for hydraulic service up to 5000 lbs. pressure. Ask for Bulletin 933 describing "Nicholson" Control Valves.

STURDY STEAM TRAPS WITH EXTRA CAPACITY



Available in Bronze, Cast Iron and Cast Steel Construction—in sizes from ¼" to 2" and for pressures from vacuum to 300 lbs. with superheat.

Nicholson Industrial Steam Traps are large in capacity, will not freeze, eliminate air binding, require no adjustment, prevent dribbing, provide intermittent discharge and never water-log. In many cases they step up process production from 20 to 30%. Used in leading industrial plants. Ask for Industrial Trap Bulletin No. 439 describing these moderately priced traps.

OTHER NICHOLSON PRODUCTS—NICHOLSON Welded Floats, Piston and Weight Operated Traps, Flexible Couplings, Expanding Mandrels, Arbor Presses, Compression Shaft Couplings, Steam Eliminators and Separators, Compressed Air Traps.

W. H. NICHOLSON & COMPANY
125 OREGON ST. WILKES-BARRE, PENNSYLVANIA, U. S. A.

COTTRELL PROCESS OF ELECTRICAL PRECIPITATION

universally recognized as a standard method of removing

DUST, FLY ASH, FUME, MIST & FOG *from* GASES

•

28 years of research development and operating experience by the affiliated Cottrell Companies throughout the world is incorporated in the

COTTRELL INSTALLATIONS

offered to meet the requirements of any problem by

RESEARCH CORPORATION

405 LEXINGTON AVENUE
NEW YORK CITY

59 EAST VAN BUREN STREET
CHICAGO, ILL.

PERSONALS

D S Mix has been assigned responsibility for Media and Publishers Relations, General Electric Publicity Dept, Schenectady, N. Y. Under his new duties he will be in charge of the work formerly handled by the late F R Davis. A native of New Haven, Conn., Mr Mix was graduated from the Sheffield Scientific School of Yale University in 1917, joining General Electric immediately on editorial work in the publicity department. Following military service he was again assigned to the publicity department. In 1929 he was made copy chief in addition to his duties as contact man, and since 1932 he has devoted his time to publicity department training programs, personnel and special assignments, which he will continue to handle.

Clinton D St Clair has been appointed works manager of Hancock Valve Div, Manning, Maxwell & Moore, Bridgeport, Conn. Mr St Clair attended Purdue University and Pennsylvania State College, and since his graduation has been associated with such industrial organizations as B F Goodrich, Erie City Iron Works and others.

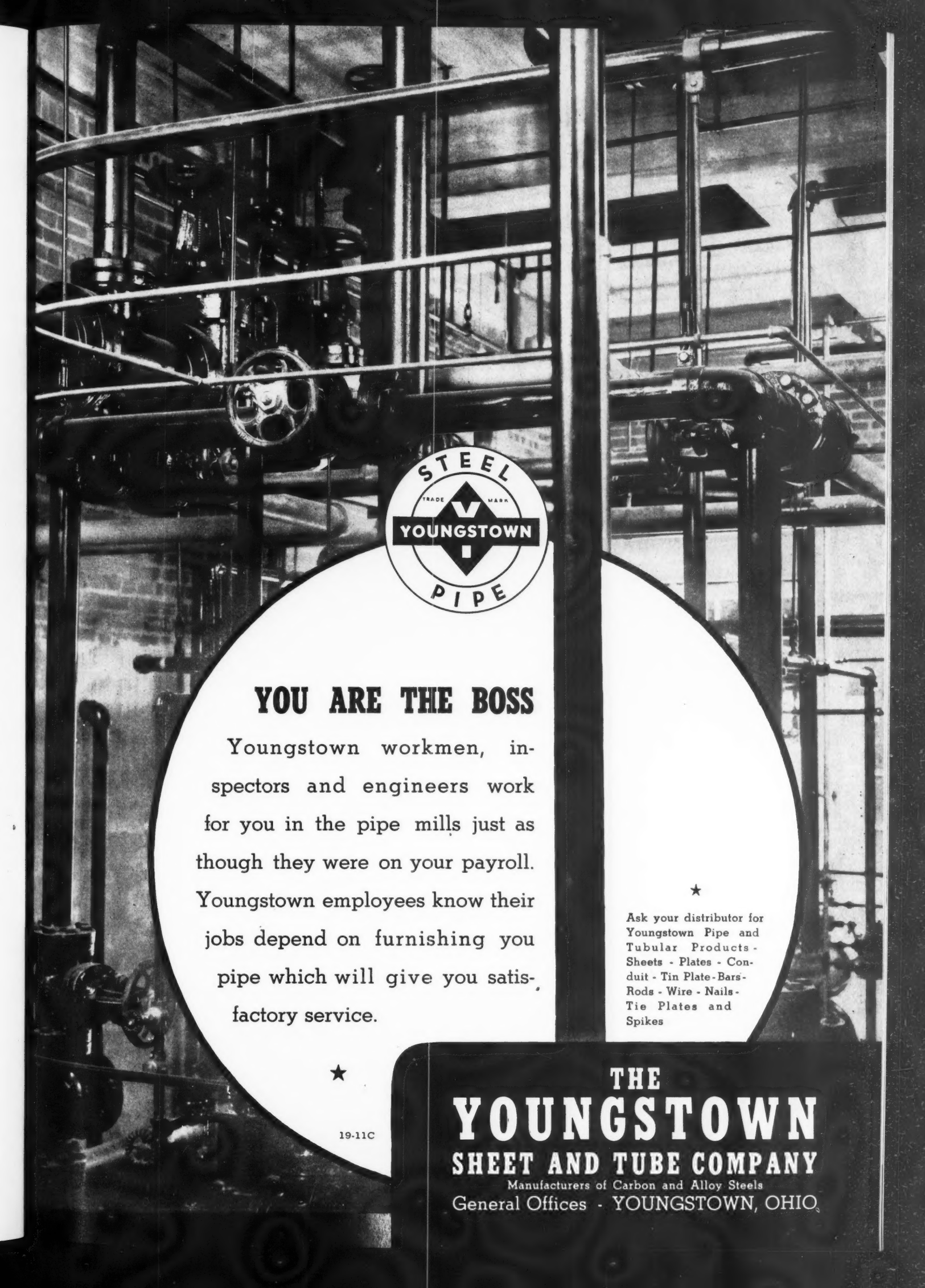
Alex S Anderson has been appointed district manager in Mid-West territory for the Duff-Norton Mfg Co, Chicago, Ill. Mr Anderson's headquarters will be at the company offices, Peoples Gas Bldg, Chicago, Ill.

Robert N Weber has been placed in full charge of department for special service to industrial customers of McQuay, Inc. He was formerly with the Air Conditioning Div, Fairbanks, Morse & Co, Chicago, and previous to that majored in heat transfer, air conditioning and refrigeration at the University of Illinois.

A D Sutherland, lately and for some years connected with the Lee C Moore Co as sales engineer, has been engaged by Chaplin-Fulton Co, as sales engineer.

Robert D Murphy has been appointed district representative of the Elgin Softener Corp, Elgin, Ill., in western and central New York. His headquarters will be in the Brisbane Bldg, Buffalo, N. Y.

Robert L Lerch has been appointed general sales manager of Haynes Stellite Co, Union Carbide & Carbon Corp. He has been associated with the company since 1924, having joined it as sales engineer in the New York district.



YOU ARE THE BOSS

Youngstown workmen, inspectors and engineers work for you in the pipe mills just as though they were on your payroll. Youngstown employees know their jobs depend on furnishing you pipe which will give you satisfactory service.

★

Ask your distributor for Youngstown Pipe and Tubular Products - Sheets - Plates - Conduit - Tin Plate - Bars - Rods - Wire - Nails - Tie Plates and Spikes

19-11C

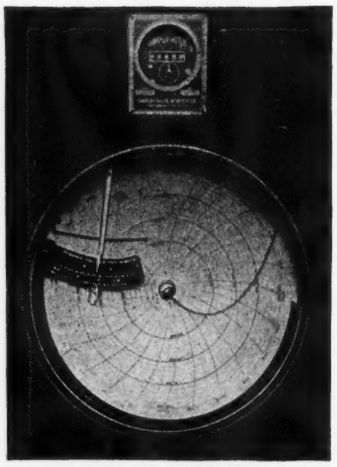
THE YOUNGSTOWN SHEET AND TUBE COMPANY

Manufacturers of Carbon and Alloy Steels

General Offices - YOUNGSTOWN, OHIO

Gives QUICK Answers To ALL Flow Questions

How much hot water is going into steam? . . . Are boilers working at top efficiency? . . . How much gas are we using each day? . . . Let a Simplex Meter give you the quick, accurate answers to these important plant flow questions.



TYPE M S METER

Simplex Meters can be used with any type of pressure producing device (orifice, nozzle, venturi tube) in any size of main to totalize the flow of Boiler Feed Condensate, Steam, Air, Gases and Corrosive Liquors. It is extremely accurate and reliable over wide ranges. And its modern price puts it within easy reach of every plant. Write for new descriptive bulletin.

SIMPLEX VALVE & METER CO.
6780 UPLAND ST., PHILADELPHIA, PA.

ALL YOU NEED TO KNOW

For the prevention and removal of boiler scale and corrosion.

"The Entirely Different Boiler and Engine Treatment"

BE A SKEPTIC—Ask for proof on this safe certain and economical way.

AMERICAN SAND-BANUM COMPANY, Inc.
9 Rockefeller Plaza New York City

WESTERN SAND-BANUM CO.
Houston, Texas Fresno, Calif.

Export Representative, PETROLEUM MACHINERY CORP.
30 Rockefeller Plaza New York City

Since 1929 he has been advertising manager and assistant to general sales manager.

GEORGE A BRYANT, executive vice-president and general manager of the Austin Co since 1930, has been elected president and general manager, succeeding the late W J Austin. A native of Chicago, Mr Bryant received his engineering education at the University of Illinois and first became associated with the company 27 years ago. In 1916 he was named district superintendent for all Austin operations in New England, and shortly after became manager of the company's Philadelphia office. Later, in 1918, he was made general sales manager for the entire country, which responsibility he carried until early this year.

FRED R LOWELL has been recently appointed manager of engine sales for National Supply Co, Springfield, Ohio. Mr Lowell has been affiliated with the organization since 1936, when he assumed charge of company's commercial engine sales in the Southwest. In January, 1940, he was transferred to Springfield to become manager of oil-field engine sales, and occupied this position until the time of his present appointment.

A R WEIS, president and general manager of Pacific Pump Works, Los Angeles, has been elected to the Board of Directors, Dresser Mfg Co, Bradford, Pa. He has for many years been identified with the development of heavy-duty centrifugal pumps for power plants. He became president of the Pacific company, a subsidiary of the Dresser organization, in October, 1940, after serving as vice-president and chief engineer since 1924.

N E DREXLER, vice-president and general manager of the Newport News, Va., Power Co, and vice-president of the Virginia Public Service Co, has been elected president of the Tidewater Power Co.

WOODBURN C WININGS, manager of the Mechanical Goods Sales Dept, Goodyear Tire & Rubber Co, was honored at the close of his 25th year of service with the company in December, 1940. Joining the company in 1915 as general line salesman at Indianapolis, following graduation from college, his service was only interrupted by the first World War. Upon his return from military service he was appointed mechanical goods sales representative at Chicago. Made manager of the Indianapolis branch in 1926.

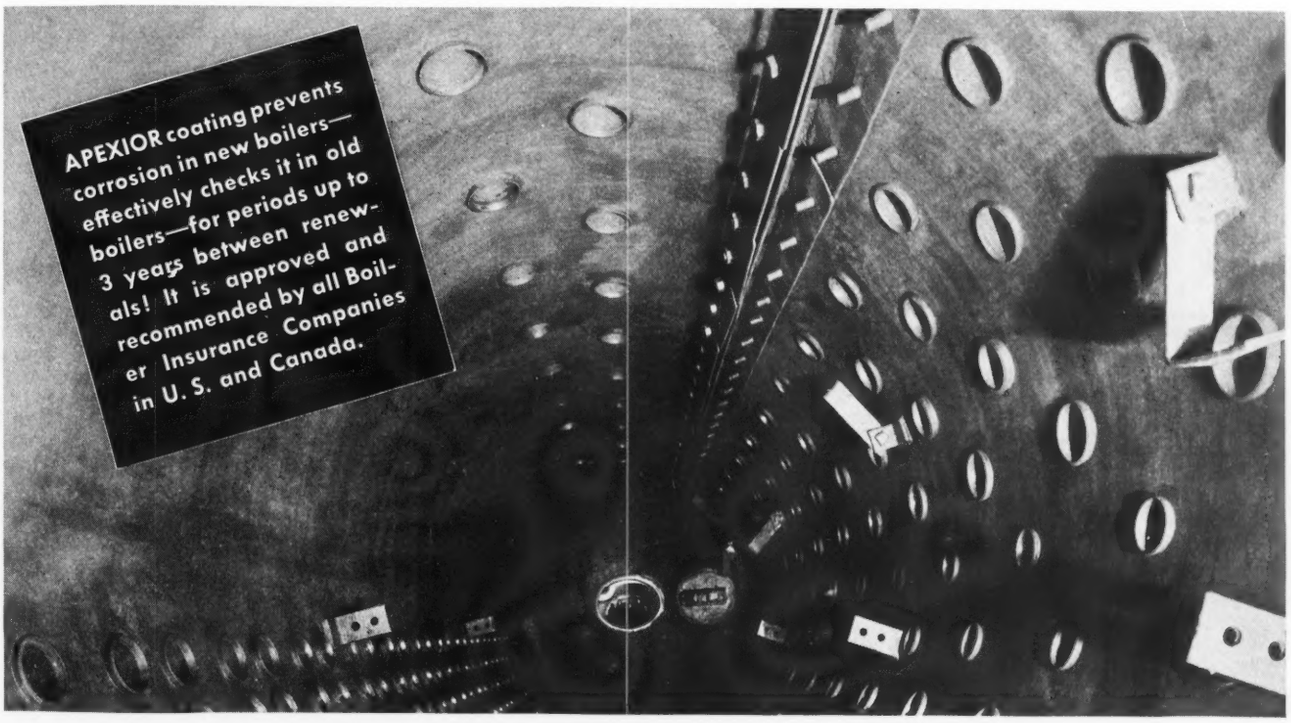
Industry's 3-Shift Schedule Means

Your Boilers Need APEXIOR PROTECTION All the More!

If your plant is running two or three times longer each day than under normal conditions . . . then your boilers are being forced to evaporate two or three times as much steam as the normal requirement.

THAT MEANS . . . 2 or 3 years of service packed into 1 year! 2 or 3 times the wear on interior surfaces! 2 or 3 (or more*) times the need for the *corrosion protection* APEXIOR provides!

*Additional hazard to interior surfaces is due to overload and unusual physical and chemical conditions incident to a sustained higher rate of evaporation.


APEXIOR coating prevents corrosion in new boilers—effectively checks it in old boilers—for periods up to 3 years between renewals! It is approved and recommended by all Boiler Insurance Companies in U. S. and Canada.

SAVE BOILER CLEANING TIME — KEEP BOILERS ON THE LINE LONGER

APEXIOR prevents the tight bonding of water scale. Cleanings are less frequent — and when necessary, can be completed in much less time.

NEW COATING MACHINE CUTS COATING TIME

The new Tube Coating Machine with air motor agitation, duplex air and fluid line and forced feed to the expanding brushes (through a specially-constructed air turbine) . . . has greatly reduced tube coating time, at the same time improving quality and uniformity of the coverage.

APEXIOR-ize now . . . establish a basis for better, easier and lower cost maintenance in '41. Write today for bulletin 1300.

APEXIOR
REG U.S. PAT. OFF.

THE DAMPNEY COMPANY OF AMERICA

PROTECTIVE COATINGS FOR STATIONARY BOILERS, LOCOMOTIVES AND STEAMSHIPS

HYDE PARK · BOSTON · MASSACHUSETTS

Atlanta Chicago New York Detroit Philadelphia

Engineering Sales Representatives — Pittsburgh, Cincinnati, New Orleans, San Francisco, Los Angeles, Portland, Seattle, Phoenix, Denver, Salt Lake City, Dallas, Houston, Vancouver, B. C., Montreal, P. Q., Havana, Cuba, Manila, P. I., Honolulu, T. H., Marine Dept., 114 Liberty Street, New York, N. Y.

EUREKA PACKINGS FLAX — ASBESTOS RUBBER — METALLIC

AMBEST—the Universal Packing

available for all pressures and temperatures up to 550° F.

Good till the last stroke on any good rod—universal for reciprocating or centrifugal rods. Try "AMBEST" on your engines, pumps, compressors, throttles, steam valves, condensers and any other applications where you want the utmost in packing protection, ease of application and low packing cost.

SEND FOR THE 36-PAGE EUREKA CATALOG

Select the packing you need—and TRY IT. Results will convince you that "EUREKA" is the packing for you.

PATENTED "EUREKA" TRADE MARK

EUREKA PACKING CO., 294-296 46th St., BROOKLYN, N. Y.

A Powerful Cleaner for Small Tubes

ROTO Junior

ACTUAL SIZE photo of Model 34 Roto Junior with wire-flexible coupling, expanding brush and air valve for one-man operation.

FOR cleaning light scale from small tubes in condensers, superheaters and other heat exchangers, the fully self-contained Roto Junior offers advantages possessed by no other type of cleaner.

The Roto Junior is extremely simple. It has only two moving parts, and is built on the same time-tested principles as our larger cleaners. Its unusual power for its size is due to the positive contact between the solid blade and the Roto-centric bore, which provides an undivided air stream, free from all leakage. An air valve behind the motor permits one-man operation. Very little head room is required. Cleans either vertical or horizontal tubes, and tube bundles need not be removed.

Other Roto Cleaners are available for straight and curved tubes up to 12" I. D. and for every type of deposit.

WRITE FOR DETAILS

SEE OUR ADV. IN SWEET'S

Inexpensive, quickly replaceable sections for Roto expanding brushes as above, greatly reduce cleaning costs.

The ROTO Company

145 SUSSEX AVE. NEWARK, N. J.

in June two years later was promoted to assistant manager of Mechanical Goods Sales Dept in Akron. He was made manager of that department in 1930.

HARRY ERLICHER, purchasing agent of General Electric Co since 1931, and an employee of the company 40 years, was elected a vice-president recently. He will continue to be in charge of company's purchasing activities.

CHARLES W CRISTAL has been appointed sales manager of Electrical Construction Dept of Dingle-Clark Corp, Cleveland, Ohio. Mr Cristal is a graduate of the U. S. Naval Academy and of the Massachusetts Institute of Technology.

HERBERT F KAUFFMAN, formerly connected with the Dampney Co of America, Hyde Park, Mass., has joined the Boston office of the Patterson-Kelley Co. His headquarters will be at 96A Huntington Ave, Boston.

H N RAMSEY has been made purchasing agent of the Philadelphia Electric Co, replacing R G RINCLIFF, who was appointed manager of Station Operating Dept. He entered the service of the American Gas Co in 1920, and later became assistant to the general superintendent. Since 1934 he has been president of the Welsbach Co.

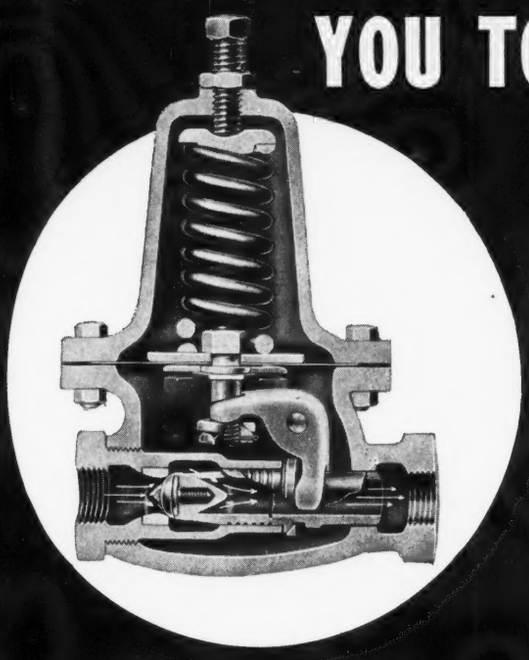
GEORGE B KUTZ was recently appointed district sales manager for the southeastern territory of Wright Mfg Div, American Chain & Cable Co, York, Pa. He has been associated with American Chain for many years, being district sales manager at Chicago, and located at York, Pa. He will make his headquarters in Atlanta.

LOUIS R BOTSAI has been appointed manager of the Gearing Dept, East Pittsburgh Div, Westinghouse Electric & Mfg Co. For the past three years he was sales manager of the company's Small Motor Div, at Lima, Ohio.

MICHAEL J RAFTUS, engineer in Steam Heating Plants Div of Boston Edison Co for 23 years, retired on Jan 1. A dinner was given in that city in his honor.

LYLE J MORSE, for the past five years an engineer in the electrical technical div of Boston Edison Co, has been transferred to system despatcher's office. He was formerly in the Power Interchange Div and at one time was assigned to the Standardizing and Testing Department.

IF YOU KNEW *what users know* YOU TOO COULD SAY—



"low cost performance"

"trouble-free service"

"accurate regulation"

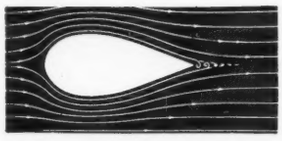
"tight closure when not in use"

"no service attention"

"high capacity"

"speeds production"

NONE OF THIS TURBULENCE
In the Streamlined Valve there is no turbulence like that indicated in the diagram above to hinder flow or handicap close pressure regulation.



GIVES THIS FLOW PATTERN
The Streamlined form of the inner valve eliminates turbulence. It produces the flow pattern shown above which makes for maximum capacity when it is needed most, and permits accurate pressure control under toughest working conditions.

USERS SAY—
Lots of Valves must be working well because no troubles reported —

"We've got a lot of your Streamlined Valves here and they must be working well because I haven't had a single case of trouble reported on them. When something works well we usually stick to it, so you'll be hearing from us right along."—Case No. 366.

Wanted dependable Valves — Streamliner stood Lab tests — 5 years of plant experience confirms Lab test —

"Bought the first '1000' Valve because we were on the hunt for a dependable Valve. Laboratory tests were so good we standardized on it. Plant use confirmed Lab tests. With practically no trouble with any of these Valves over a five-year period, we are not on the hunt anymore."—Case No. 369.

CASH STANDARD *Streamlined* TYPE 1000 PRESSURE REDUCING VALVES

have straight line flow from inlet to outlet . . .

Why not find out why users get no failures with the CASH STANDARD Streamlined "1000" Valve — why it gives them much longer, lower-cost service, and why attention costs are materially decreased.

It Costs You Nothing to Find Out

You can get the CASH STANDARD Streamlined Type 1000 Valve working for you at once — at no cost you can experience the benefits of this "straight line flow" construction.

Simply send for a Type 1000 on 30 days' FREE TRIAL. After 30 days a bill is sent to you. You either pay the bill or return the valve to us at our expense.

Once on your lines, Type 1000 insures maximum capacity and close delivery pressure control. You'll find that there are no complicated parts to get out of order — no small ports or passages to clog up — no close fits — also that you are easily able to meet peak demand and yet hold the pressure constant at the same time.

Order one on Free Trial now!

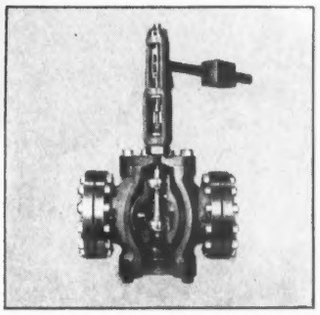
CASH STANDARD CONTROLS . . VALVES

A. W. CASH COMPANY
DECATUR, ILLINOIS

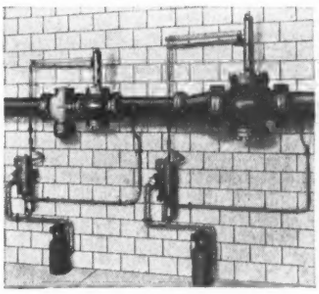
A CASH STANDARD "GET ACQUAINTED" COLUMN

Question: "Don't you people make anything besides that Streamlined Valve you talk about so much?"

Answer: "Yes Sir; we do! And we propose to picture one or two of them here each time."



For precision jobs — the CASH STANDARD "42-R" Balanced Lever Valve. No lost motion; practically no maintenance. Heavy renewable seat rings; valve stem integral with inner valve. Roller guides kill side strains and stop packing trouble. Comes with parabolic inner valve; flat bevel seat; V-port seat; and V-port non-seating types. Made in sizes ½" to 12" inclusive. For use with pressures up to 600 lbs. Highest temperature 800 deg. F. In iron, bronze, and steel bodies; all standard trims. This valve is made also with center guide, and with Water Cooled, or Air Cooled Packing Box.



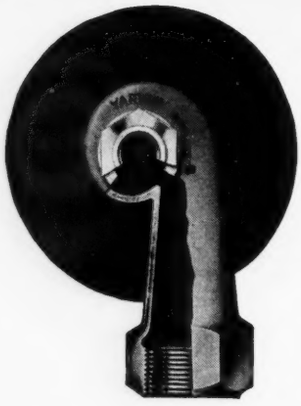
Where valve failure would be costly, here are two "42-R" Valves operated by CASH STANDARD Type 100 Automatic Controllers, in two-stage pressure reduction. First stage: a 5" Valve reducing 150 to 50 lbs. gauge; second stage: an 8" Valve reducing 50 to 5 lbs. gauge. Load 70,000 lbs. steam per hour. Nearly four years' daily use; not a moment's trouble. (Single stage would have been entirely satisfactory, but customer insisted on double stage reduction.)

Get Free Bulletins on Above . . . Write to
A. W. CASH COMPANY
DECATUR, ILL.

ADVERTISING PAGES REMOVED

YARWAY

INVOLUTE SPRAY NOZZLES



Unique Yarway Involute design.

No internal parts or vanes to clog or erode.

Unobstructed flow gives minimum loss of head.

Finely divided spray cone provides rapid cooling.

Renewable orifices adapt nozzles for any service.

Installations total more than 5 million gallons per minute in water cooling and air conditioning service.

Made in both cast and bar-stock types. All sizes from 1/4 in. to 2 1/2 in. Write for Catalog N-615.

YARNALL-WARING COMPANY
100 Mermaid Ave. Philadelphia

New Bulletins

BOILERS AND ACCESSORIES

1 STACKS — Prat-Daniel Corp, Port Chester, N. Y. 12-page catalog No. 109 covers various types of Thermix stack installations, including dust-collector stacks, recirculator stacks and fans, Multicyclones, and others.

2 SMOKE INDICATORS—Brooke Engineering Co, 4517 Wayne Ave, Philadelphia, Pa. 4-page folder describes operation and parts of photoelectric smoke-density indicator and recorder. Line drawings show dimensions of important parts.

3 CONDENSER REPAIRS—C & C Corp, 381 Fourth Ave, New York, N. Y. 4-page bulletin No. C-41 describes, illustrates, and points out advantages of C & C method of condenser tube pulling, stretching and cutting. Line drawings clearly show procedures involved.

ELECTRICAL EQUIPMENT

4 CIRCUIT BREAKERS—Allis-Chalmers Mfg Co, Milwaukee, Wis. 4-page folder No. B6129 describes Types, DZ-60A, DZ-100A, and DZ-200A oil circuit-breakers. for 200 amp or less, 15,000 volts, up to 500,000 kva interrupting capacity. All parts of breaker shown separately, with brief description of each.

5 TRANSFORMERS — Westinghouse Electric & Mfg Co, East Pittsburgh, Pa. 16-page descriptive data 211 describes CSP self-protecting power transformers. Advantages of unit-substation transformers explained with special reference to reliability, flexibility and cost per kva installed. Four pages of application data include diagrams of different distribution arrangements.

6 GENERATORS—Burke Electric Co, Erie, Pa. 4-page illustrated folder describes ac synchronous generators for diesels. Stator described in detail, as is rotor, with cross sections. Brief item on Burke exciters included.

7 TRANSFORMERS — Allis-Chalmers Mfg Co, Milwaukee, Wis. 16-page bulletin No. B-6084 covers assembly and installation of A-C power transformers. Booklet is filled with installation views; short items explaining each included.

AIR CONDITIONING & REFRIGERATION

8 UNIT HEATERS—B F Sturtevant Co, Hyde Park, Mass. 16-page bulletin No. 454 covers downblast speed heaters, giving features, capacity tables, mounting-heights and floor-coverages. Installation diagram for two typical types of buildings shown.

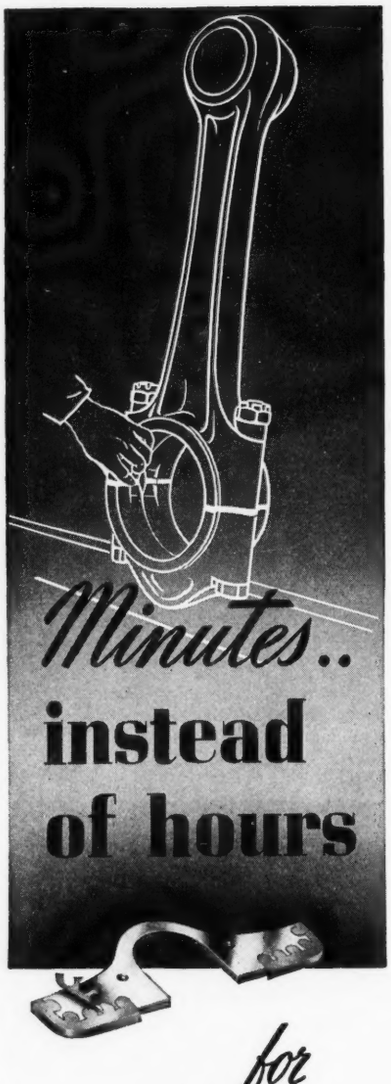
9 REFRIGERATION COMPRESSOR—Worthington Pump & Machinery Co, Harrison, N. J. 6-page folder illustrates and describes centrifugal liquid-cooling systems. Separate parts are described, such as compressor and controls, driving motor, etc.

10 BLOWERS — Roots-Connersville Blower Corp, Connersville, Ind. 6-page folder, Form No. R-5341, is devoted to discussion of positive displacement blowers for raw-water ice-plant service. Several installation views included, and curve illustrates volume and power-characteristics of positive-displacement blowers. Condensed selection-table covers capacities of various blowers listed.

11 UNIT HEATERS—Modine Mfg Co, Racine, Wis. 32-page illustrated catalog No. 140-E includes discussion of modern industrial heating and unit-heater design. Covers Modine line of horizontal-delivery unit heaters including complete engineering data, information on location and installation of unit heaters.

MECHANICAL TRANSMISSION

12 BEARING MATERIAL — Revere Copper & Brass, Inc, 230 Park Ave, New York, N. Y. 4-page folder describes Carbobronze bearing material, giving advantages, range of sizes, economical use,



for maintenance

Have your machines spend less down-time for adjustment! Countless hours are saved . . . for production . . . from first assembly to the end of bearings' life . . . by simply peeling adjustments of .002 or .003 inch from the solid laminated brass shims. No filing or costly precision grinding! • *LAMINUM shims cut to order . . . stock shim materials furnished by mill supply houses.*

Laminated Shim Co., Inc.
61 Union St., Glenbrook, Conn.

Write for file-folder of shim application photos—with Laminum sample.

LAMINUM
THE SOLID SHIM THAT peels FOR ADJUSTMENT
A-1149

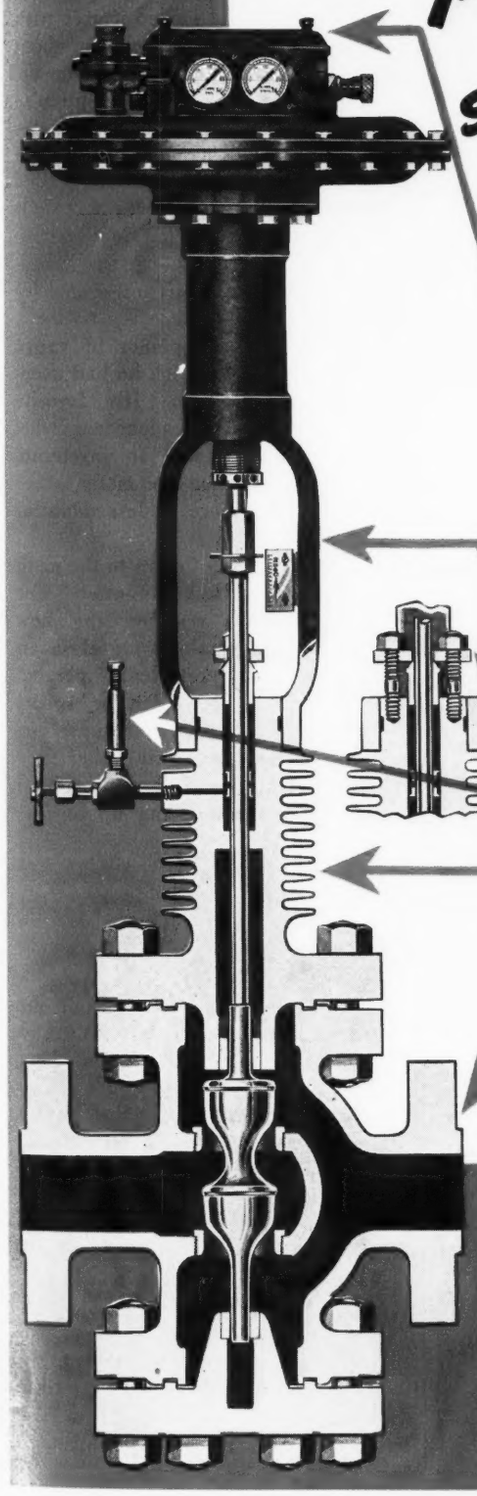
for HIGH PRESSURE POWER PLANTS

SELECT A...

FISHER

TYPE 4357 T

WIZARD PILOT OPERATED DIAPHRAGM CONTROL VALVE



Designed especially for HIGH PRESSURE STEAM service, Fisher's Type 4357T Controller incorporates every required feature. No other automatic controller so completely meets all the exacting requirements of HIGH PRESSURE STEAM service. Your control problem demands that you consider this modern pressure controller.

Fisher's famous Wizard Pilot Control built integral with diaphragm casing assures extreme sensitivity of control. Incorporates throttling range adjustment and controlled pressure setting adjustment. Action of pilot easily reversed to change main valve from reducing valve to back pressure valve or vice versa.

Extra heavy high-tensile iron yoke and spring housing plus extra strong stem provide required strength. Equipped with travel indicator and ball bearing adjusting screw.

High pressure stuffing box has self aligning packing gland and is furnished with lubricator and isolating valve.

All units equipped with air-flo cooling fin head of extra heavy construction.

1500 lb. electric cast steel body is double ported with renewable screwed-in seat rings. Inner valve is top and bottom guided ratio plug type producing fine throttling control. Both inner valve and seat rings are hardened stainless steel preventing seizing or galling.

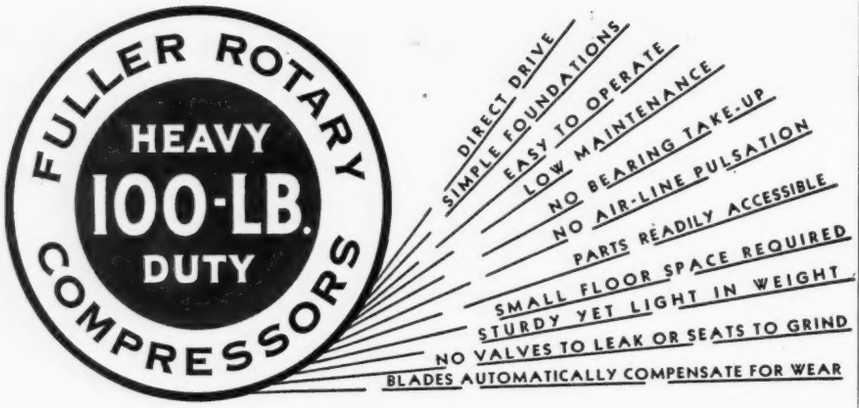
WRITE TODAY for full information and prices on Fisher Type 4357T Controller.

FISHER

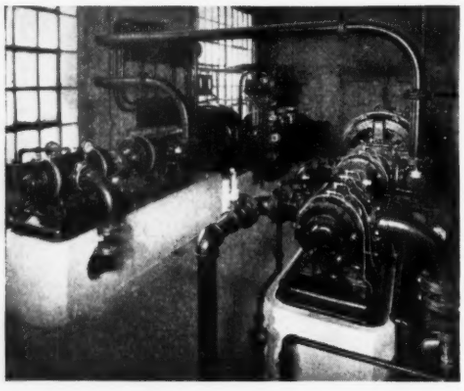
GOVERNOR COMPANY

412 FISHER BUILDING

MARSHALLTOWN, IOWA

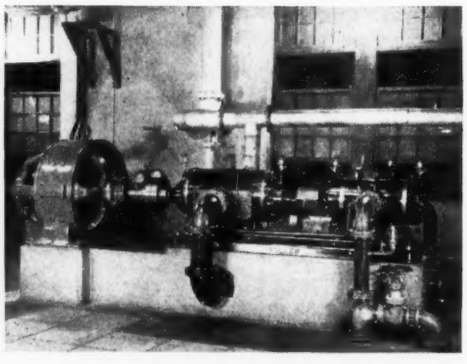


Actual operating experience demonstrates reliability of Fullers . . . available for 80 to 125-lb. service.



Left: **750 C.F.M.** each, actual free-air delivery, **100 lb. pressure**, Two-stage Rotary Compressors, installed March, 1931, in a cement plant in Pennsylvania. Plant records show that these two machines have given excellent service. One machine was operated a total of 35,162 hours and the other 23,567 hours with no maintenance cost whatsoever. More proof that Fullers are really built for 100-lb. service, with ample safety factor to spare.

Right: **1000 C.F.M.** actual free-air delivery, **110-lb. pressure**, Two-stage Rotary Compressor, installed in a tin-plate mill in Pennsylvania. This machine has been in operation over seven years, during most of this time being on six days a week, 24-hour per day service, shutting down only on Sundays . . . and this service secured with a very low cost for maintenance and repairs.



Write for Bulletin C-3A

FULLER COMPANY
CATASAUQUA, PENNSYLVANIA

Chicago: 1118 Marquette Bldg.
San Francisco: 320-321 Chancery Bldg.

C50

Fuller

FULLER-KINYON, FLUXO, AND AIRVEYOR CONVEYING SYSTEMS
ROTARY AIR COMPRESSORS AND VACUUM PUMPS
ROTARY FEEDERS AND DISCHARGE GATES
AIR-QUENCHING COOLERS · BIN SIGNALS

Argument Corner

(*Continued from page 112*)

quet spruce butchers—they're all the same to Bill. He can perform the almost incredible feat of working them together—always opined that a nasty job and a mean boss can get lots of assistance.

One bitterly-cold January morning, Bill arrived on the scene of a northern construction job. He stood amidst the frozen disorder and looked it over with critical eye. Someone asked him about his entourage. For several moments he fumbled with a lick-and-a-promise of tabac and a badly worn cigaret paper. Then he announced, "I'm all alone in me gang."

We found that that was all right with Bill, for it was not long before he had riggers, pipefitters and scrap-iron jugglers conjured from the adjacent Christmas trees.

Bill was quite a spinner of yarns, a goodly supply of which he had accumulated in his time. His favorite concerns one Henri Ladoucoeur who, according to Bill, was an inveterate poacher, in addition to many other "callings" of a more or less doubtful nature.

Henri was a sort of extra to the gang on a job around Lake Frontier. For some reason, he resented the new parish incumbent taking too close an interest in a still that Henri operated sporadically, as the spirit or spirits moved him. It was under these circumstances that the good father intimated to Henri the desire for a hind quarter of moose to hang up for the winter.

One day Henri arrived with the meat. His Reverence being absent on official duties, Henri left the meat with the housekeeper with the remark that it was original ferré.

Meeting the Father on the trail one morning later, Henri asked, "And how did you like the venison, Mon Pere?"

"Very good, my son," the Father replied; "very good. A little sweet . . . but very good. By the way, what did you mean when you told my housekeeper that the meat was 'original ferré?'"

No satisfactory answer was forthcoming, however.

Some time afterward, it developed that Henri had shot his horse on account of a broken leg about the time that the meat was delivered to the Father's house. This, presumably, was the explanation of the remark: "Shod

DOES CHISELING PAY?

It depends upon where and how you chisel. If you devote your entire energies in shopping for price alone, you probably will find a "cheap" rope and still be the loser. If, however, you consider the per-unit-of-use cost, you are "chiseling" wisely and constructively.

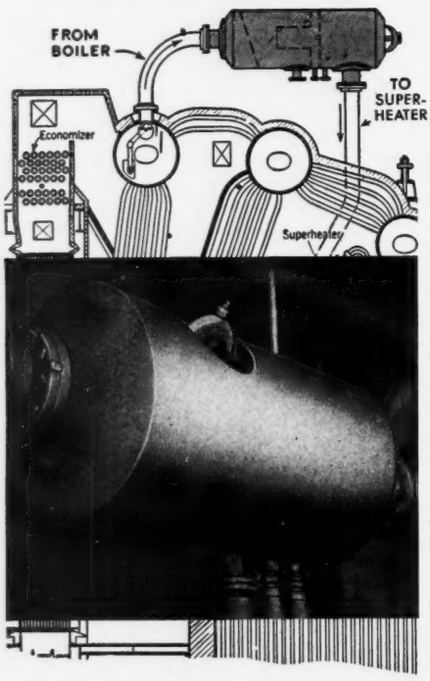
Wickwire Spencer offers every assistance to rope users in producing lower rope costs. In the laboratory and mill they develop and produce better metal and rope that in itself gives longer life. In the field, trained rope experts recommend suitable types of rope and suggest rope care in use that further reduces rope costs . . . yet the purchase price of Wickwire Rope is no higher.

WICKWIRE ROPE

WICKWIRE SPENCER STEEL COMPANY

General Offices: 500 Fifth Avenue, New York City; Sales Offices and Warehouses: Worcester, New York, Chicago, Buffalo, San Francisco, Los Angeles, Tulsa, Chattanooga, Houston, Abilene, Texas, Seattle. Export Sales Department: New York City

Extra Capacity—
from Over-Loaded Boilers with COCHRANE STEAM PURIFIERS



Here's one plant . . . that increased capacity 270% of boiler rating . . .

In a large process plant an average of 194% of boiler rating was required but 150% could not be exceeded without excessive carry-over. Cochrane Purifiers were installed and the desired conditions readily attained—a 96-hour test gave perfect results at 270% of boiler rating.

Cochrane Steam Purifiers eliminate practically all moisture and solid impurities from steam, protecting and increasing the efficiency of superheaters, turbines and other equipment.

Technical data and case studies are described in our Publication 2725. Write:

COCHRANE SEPARATORS

COCHRANE CORPORATION
3106 N. 17th Street, Philadelphia, Pa.

COCHRANE

Cochrane Corp., 3123 N. 17th St., Phila., Pa.
Please send me a copy of your Publication 2725 on Steam Purifiers.

Name.....
Firm.....
Address.....
City.....State.....

Moose" that Henri had made to the housekeeper.

Bill? No . . . he's not the "Chief". But, with his satellites—Cliff, Mattie, Albert and Mike—he's the principal reason why the Old Chief is able to run a good job and have time to look around to figure ways of improving it.

Bill is the assistant—the man who makes the wheels want to go round. Without the Bills, Matties and the others, the Old Chief would have to run a one-man band, which, anyone will agree, is a hell of a racket . . . if you want very much or very good music.

Dalhousie, N. B. R G EDWARDS

Power Lines

(Continued from page 134)

lion tons, bringing the total for the year to slightly above 450 million tons, the largest annual output since 1930. A further advance in mine output is in sight for the first quarter of the new year, due to the seasonal trend coupled with the further expansion in industrial activity all along the line. The estimated total for 1941 first quarter is 125 million tons. This compares with 119 million tons in the first quarter a year ago.

"If 12 million tons weekly—over 600 million tons annually—be taken as the yardstick of 100% capacity for the nation's bituminous coal mines as now equipped, then the production forecast for the coming three months represents approximately 80% capacity.

"Stocks of bituminous coal in the hands of industrial consumers on December 1st are reported at 43,051,000 tons and in the hands of retail dealers, 8,950,000 tons. Since mine output and consumption during December appear to have been in approximate balance, the stocks on hand at the turn of the year were probably at about the same level as on December 1st and represented a scant six weeks' forward supply on the average at current rates of consumption. Some further accumulation in stocks during the coming quarter is anticipated."

Three 1000-Hp Diesels for Arizona Plant

The United States Government has ordered three 1000-hp convertible gas-diesel engines for the power plant at Fort Huachuaca, Arizona, from Enterprise Engine & Foundry Co.

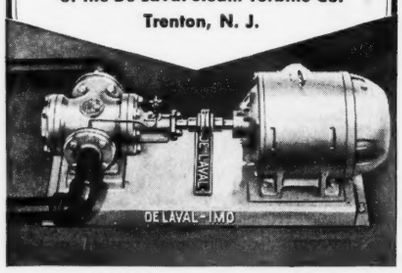
These 8-cylinder engines, equipped with 700-kw generators, will augment the 6-cylinder, 750-hp Enterprise engine of similar design installed last year. The new engines will replace some of the earliest diesel engines built in this country years ago.

Let us show you an IMO at work

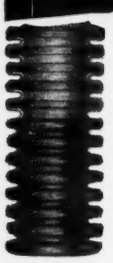
The De Laval-IMO Oil Pump

runs quietly, without vibration or pulsation, at standard motor, or even turbine, speeds. There are no gears, valves or reciprocating or unbalanced parts and the oil is delivered smoothly, as from a piston moving always in one direction. IMO pumps handle all grades of oil against all pressures. The photograph shows an IMO pump supplying fuel oil to burners in a steel mill. Ask for Catalog 1-67.

IMO PUMP DIVISION
of the De Laval Steam Turbine Co.
Trenton, N. J.



ECLIPSE SEAMLESS FLEXIBLE METAL HOSE



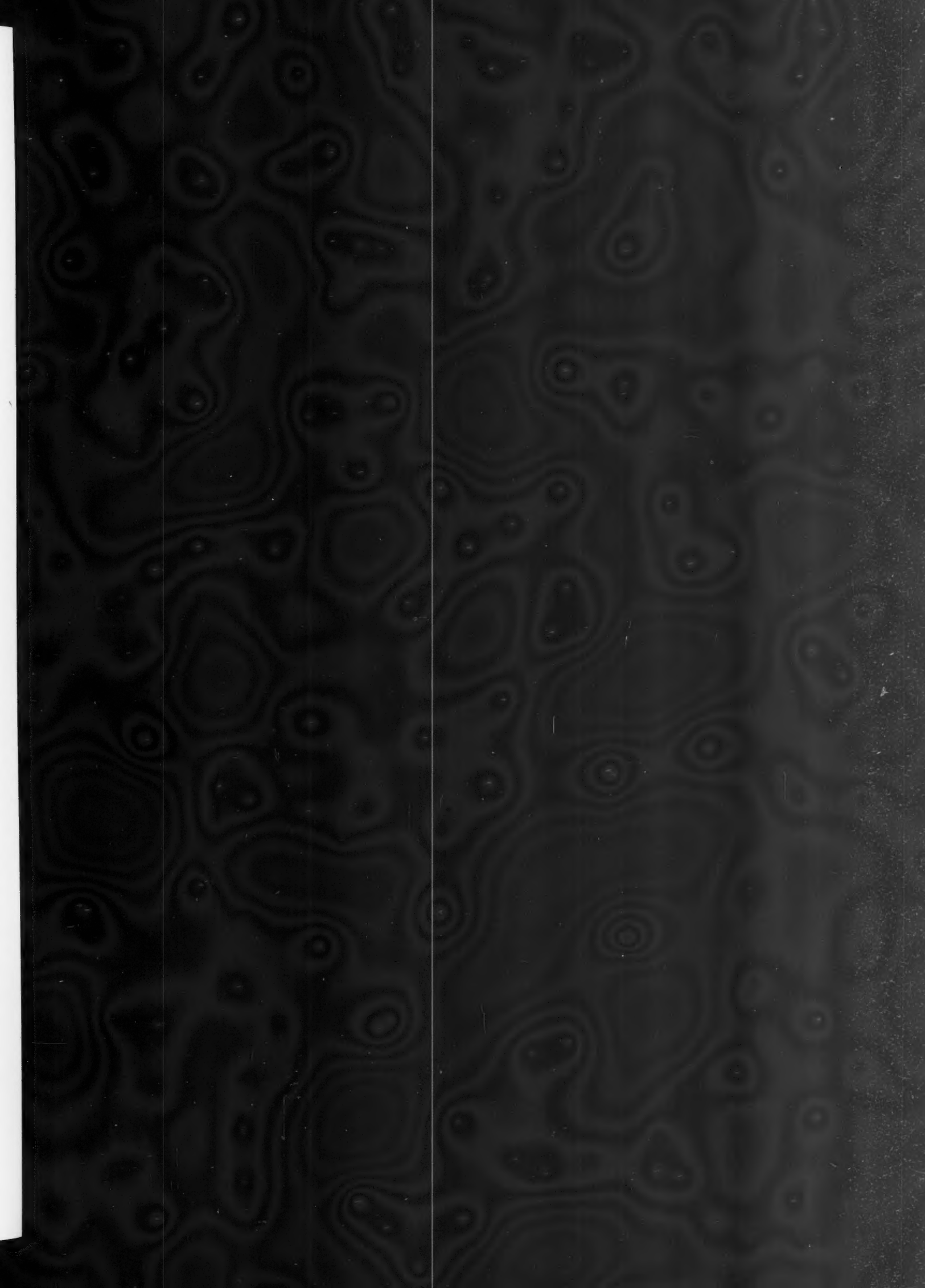
Normal Pitch

Of seamless, all metal, parallel corrugated, armored construction, in various alloys with renewable type fittings approved for the conveyance of non-solids and non-abrasives in *Aviation, Automotive, Marine, Heating, Air Conditioning, Mining, Power Generation, Plastic and Textile applications* wherein conditions of flexing and expansion between delivering and receiving connections exist. Also available for shielding and exhaust applications.

Close Pitch

"Listed by Underwriters' Laboratories"

METAL HOSE DEPARTMENT
ECLIPSE AVIATION, BENDIX, N. J.
DIVISION OF BENDIX AVIATION CORPORATION



Two ways to keep your Boilers free from CORROSION

THE HARD WAY

1 ***You can keep tubes and sheets in top condition by replacing them as fast as they corrode. But this is costly and means boiler shutdowns. What's more, it is hard work.***

Since dissolved oxygen is the principal corrosion accelerator, properly balanced feedwater treatment and control is necessary in order to provide full correction. None of the details that make up standard and accepted water treatment practice can be safely overlooked in making a survey of your steam plant requirements.

Water samples are carefully analyzed in this modern Dearborn laboratory.

THE DEARBORN WAY

2 ***A better way is to call in a Dearborn engineer to treat your water. Then, by controlling the feed with regular tests, you can eliminate all corrosion.***

Dearborn Water Treatment is recommended and prepared to maintain definite and correct conditions in your boiler water. It is designed to fit the special operating conditions of your individual plant. It not only prevents corrosion, but is balanced to provide full protection against scale and to reduce the possibility of steam contamination.

In over 8,000 plants, Dearborn Treatment has been giving complete satisfaction for many years. Dearborn engineers will be pleased to make an analysis of your plant and show you what savings can be made.

DEARBORN CHEMICAL COMPANY
Dept. D, 310 S. Michigan Ave., Chicago, Illinois

Dearborn
TRADE MARK REGISTERED

WATER TREATMENT and Engineering Service

CHICAGO · NEW YORK · LOS ANGELES · TORONTO and PRINCIPAL CITIES

MAXIM
SILENCERS

SPECIFIC SILENCERS FOR SPECIFIC PROBLEMS

An outstanding advantage of Maxim's complete line of silencing equipment is the fact that you can select the specific silencer that exactly fits your specific requirements. The result is that you do not have to buy more silencing than you require . . . nor do you have to "get by" with less silencing efficiency than you really need . . . because you'll be able to find a Maxim that fits your particular picture.

This is important because conditions under which installations are made vary so widely. Some quiet localities demand complete silencing . . . others with a high level of outside noise only call for good muffling. With Maxims you can obtain a silencer to answer either problem . . . (and many gradations in between).

Maxim makes silencers for internal combustion engine exhaust or intake, high or low pressure steam discharges, compressor intakes, blowers, etc. Send in attached coupon for further details.

THE MAXIM SILENCER COMPANY
92 Homestead Ave., Hartford, Conn.

Please send details on your ☐ Engine exhaust ☐ Steam ☐ Compressor Silencers.

Name.....

Company.....

Address.....

City.....

State.....

Scholarships for Future Engineers

To assist the National Defense program by providing urgently needed engineers, Cornell University recently launched a campaign to find the 50 best-qualified secondary-school seniors to be trained as engineers. They will be awarded John McMullen Regional Scholarships in Engineering this spring.

The scholarships carry variable stipends up to $400 a year throughout a 4- or 5-year course in the College of Engineering. The bases of awards are character and general ability as well as academic distinction. Applications must be filed with the dean of the College of Engineering by April 1.

Pacific Heating Show Set for June 16-20

Plans for Pacific Heating & Air Conditioning Exposition are progressing, according to reports from Exposition management. The event is to be the largest of its kind to be held on the coast, and is already attracting professional and industrial interest. It will be held in the Exposition Auditorium, San Francisco, Calif., June 16–20.

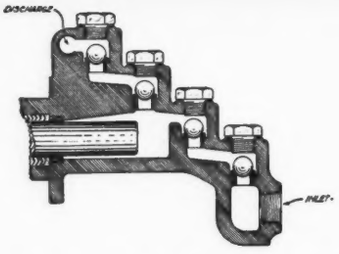
The exposition will present a summary of the latest available equipment for heating, ventilating and air conditioning. Included among the exhibits will be displays of air-conditioning equipment, boiler and furnaces, fans and blowers, control apparatus, etc. The American Society of Heating & Ventilating Engineers, which is sponsoring the event, will hold its annual summer meeting during the same week.

Midwest Power Conference in Chicago, April 9-10

The 1941 meeting of the Midwest Power Conference will be held on April 9 and 10, at the Palmer House, in Chicago, Ill. This conference is sponsored annually by the Illinois Institute of Technology with the cooperation of seven other midwestern universities and colleges, and the local sections of the Founder and other engineering societies.

The tentative program of the 1941 meeting, as outlined by the directorate of the conference, includes sessions on Central Station Practice, Stationary Prime Movers and auxiliaries, Hydro Power, Electric Power Transmission and Distribution, Feedwater Treatment and Industrial Power Plants.

MILTON Roy PUMPS
Chemical Feeders and Proportioners



This EXCLUSIVE Step-Valve Construction...

- gives Milton Roy Pumps maximum efficiency of displacement
- gives high capacity for low power expenditure
- automatically discharges air and dirt particles
- eliminates air-binding and valve-seat grooving
- provides ready accessibility without disconnecting pump from line

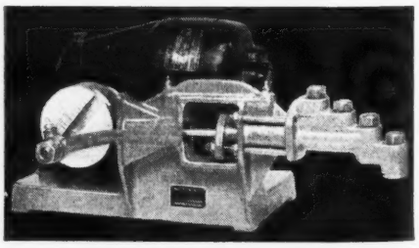
Milton Roy Pumps were developed especially for pumping boiler-treating chemicals into the water system and against all boiler pressures . . . in exact desired volume . . . without clogging or corroding.

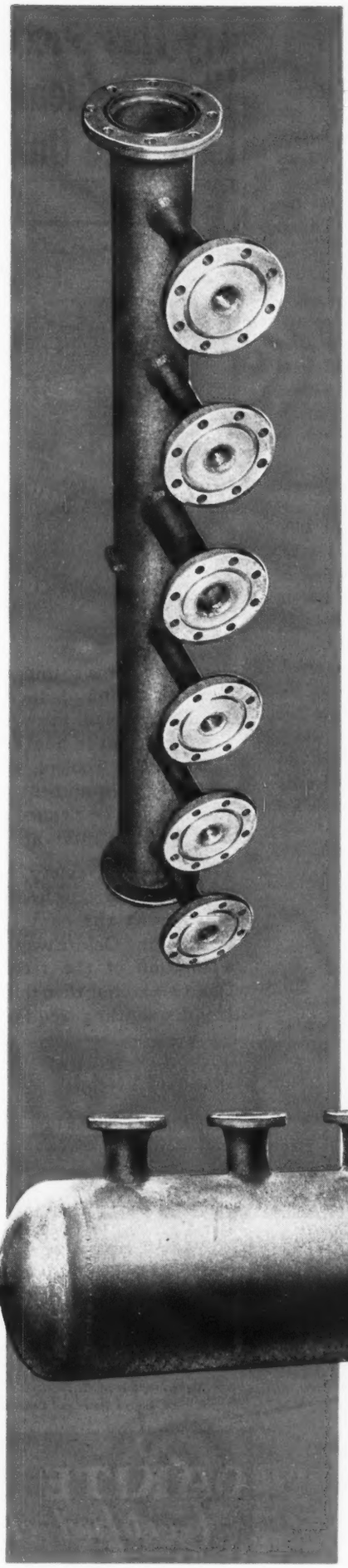
Widely used by leading utilities and industrial power plants.

These are simple, rugged, dependable units with integral gear motor drive. Their capacity is easily adjusted from zero to maximum. Models are also available with micro-adjustment of capacity while pump is running.

Made in single or multiple units for pumping two or more chemicals simultaneously. Automatic control equipment to effect proportional flow is available.

MILTON ROY PUMPS
1362 E. Mermaid Ave., Chestnut Hill, Phila., Pa.





IMPORTANT

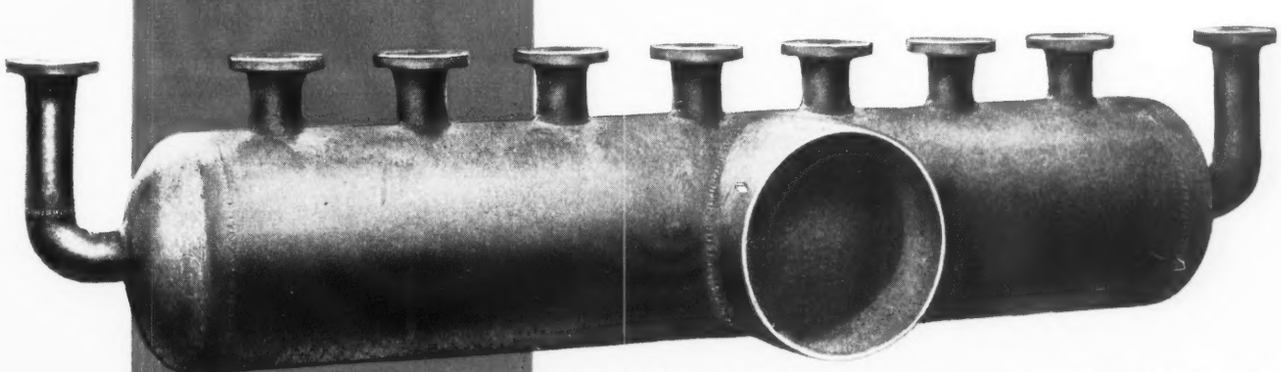
6 IN. OR 30 IN.

THE QUALITY IS THE SAME

Kellogg prefabricated piping assemblies, simple as those shown here, or as intricate as required for the most individual conditions — ranging in pressure from 200 to 2200 pounds—are installed in various power plants in this country.

Accurately prefabricated and thoroughly tested in the Kellogg shops these assemblies are shipped ready to connect, saving time and money on the job.

In fact, consulting engineers, operators of central stations, industrial and marine power plants, find that pinning the responsibility for piping on The M. W. Kellogg Company is the most satisfactory solution to their problems.

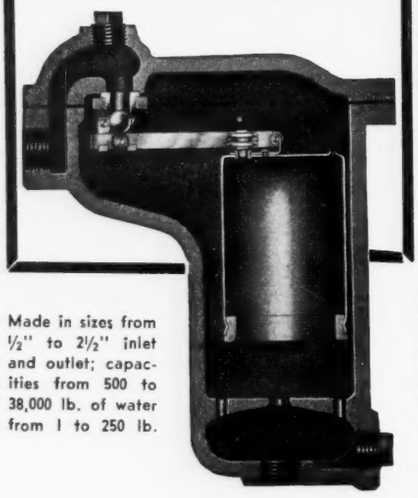


KELLOGG

THE M. W. KELLOGG COMPANY
JERSEY CITY, N. J. · 225 BROADWAY, N.Y.
Representatives:
LOS ANGELES: 609 SOUTH GRAND · TULSA: PHILTOWER BLDG.

"Masterflex" Prefabricated Piping Systems · "Masterweld" pressure vessels for Power, Refinery and Chemical Industries. Heat Exchangers. Pyrolytic and Catalytic Cracking Units, Reforming, Dehydrogenation, Alkylation, Desulphurization. Thermal and Catalytic Polymerization Units · JUIK Processes for Lubricating Oil Plants. Plastic Refractories · Radial Brick Chimneys.

Here's the TRAP to end all your TRAP TROUBLES



Made in sizes from ½" to 2½" inlet and outlet; capacities from 500 to 38,000 lb. of water from 1 to 250 lb.

THE CRYER STEAM TRAP

This quick venting, all-purpose, INVERTED BUCKET TYPE TRAP is designed to eliminate binding, dribbling, slow venting and unreliable, troublesome slow drainage. It is easily installed, positive in action and guaranteed for performance. Its the trap to put an end to your trap troubles.

6 FEATURES GUARANTEEING DEPENDABLE, LOWER COST PERFORMANCE

1—*It's Accessible*—all mechanism can be removed without disconnecting piping.

2—*It's Positive Acting*—correct seating is insured by free turning ball valve.

3—*It's Quick Venting*—air is discharged rapidly without regard to temperature through a mechanically controlled quick venting valve.

4—*It has Large Capacity*—sudden surges are prevented by baffle plate from lifting bucket and closing valve — action is fast because of quick venting.

5—*It is low in maintenance*—wearing parts are of stainless steel — free-turning ball valve minimizes wear — valve seat is easily removed — cleaning is simple and easy.

6—*It won't bind*—all air is discharged *before* condensate through valve at top.

PAYS FOR ITSELF

The Cryer Steam Trap quickly pays for itself in steam savings and through stepped-up efficiency in steam distribution.

PERFORMANCE GUARANTEED

All Cryer Steam Traps are guaranteed to discharge condensate at rated capacities and to operate satisfactorily within the limits of pressure and capacity.

TRY A CRYER

Ask for complete details. Put a CRYER on your most troublesome steam line and see how quickly it solves your problem. Write TODAY.

CRYER

TRAP & VALVE CO., INC.

366 Madison Ave.,

New York, N. Y.

Manufacturers of Steam Specialties for more than 40 years.

1940 Power Demand Up

Increase in business activity, which has accompanied the national defense program, the placing of foreign war orders and the buying by private business for inventory purposes, has been reflected in a considerably enlarged demand for electricity, according to the year-end report published by the Edison Electric Institute.

Generating capacity added in central stations contributing to public supply in 1940 amounted to 1,790,000 kilowatts. Net gain in generating capacity after deducting for equipment retired from service or reduced in capacity rating, was 1,380,000 kw, bringing total generating capacity at end of the year to 40,330,000 kw.

For the country as a whole, continues the report, the sum of the peak loads on the various systems was about 10% above the similar figure for last year. Generating capacity to be installed in 1941 by plants contributing to public supply amounts to 3,412,000 kw. In 1942 these plants will add 2,302,000 kw, according to reports so far received.

Because of the part they play in the defense program, it is noted that isolated industrial steam plants, which added 120,000 kw during 1940, will add 251,000 kw in 1941, and have already scheduled the installation of 110,000 kw in 1942. Thus the grand total of new capacity which will be installed in the next two years is 6,076,000 kw.

Cornell to Build High-Voltage Lab

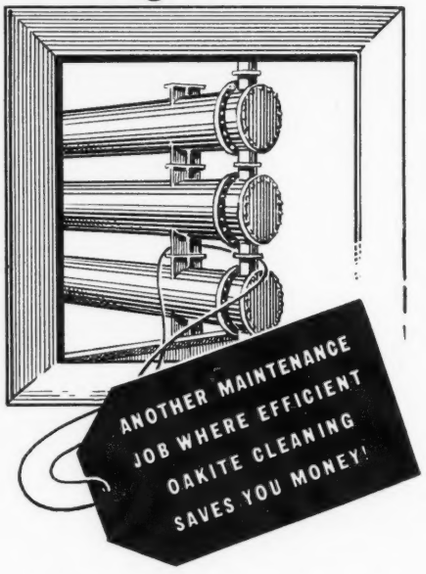
Construction of a new $150,000 high-voltage laboratory for the College of Engineering has been authorized by the Board of Trustees of Cornell University. The building, 72 by 120 feet, will be of steel construction, providing an electrostatic shield to keep the effects of high voltages within the lab.

It will be provided with 60-cycle and impulse-testing equipment. The 60-cycle equipment will be capable of providing a voltage of 750,000 volts, single phase, or 433,000 volts, 3-phase, which is sufficiently high to test equipment for higher voltages than any now in use. The impulse testing equipment will be able to simulate natural lightning up to a maximum of 3,000,000 volts.

Connersville Adds Diesel

The city of Connersville, Ind., has placed with the Cooper-Bessemer Corp, an order for one of its type JS diesel engines, to form an addition to present

Try This Successful Way To Clean Heat Exchange Units



Heat transfer is so important from the standpoint of operating efficiency of fuel oil heaters, oil coolers, feed water heaters, Diesel jacket-water coolers, gas coolers and similar equipment, that these units should be cleaned at reasonably frequent intervals.

For economy, safety, thoroughness . . . clean your heat exchange equipment the easy, low-cost, time-saving Oakite way. Circulate a solution of the recommended Oakite material, then flush system. No dismantling required. Units go back in service quickly. Operating efficiency is restored.

GET THIS BOOKLET!

Here in this booklet is concise data you will want to have for reference. It is yours for the asking. Write for your **FREE** copy and tell us the equipment you want to clean. We can help. No obligation.

OAKITE PRODUCTS, INC.

23 Thames Street, New York, N. Y.

Representatives in All Principal Cities of the United States and Canada.

OAKITE *Certified cleaning*

MATERIALS & METHODS FOR EVERY CLEANING REQUIREMENT

DO YOU NEED POWER CABLE NOW?

HERE ARE 372 ITEMS YOU CAN GET RIGHT OFF THE SHELF

DELIVERIES today on 'most everything are becoming more and more important, and that applies of course to insulated power cable. You can save a lot of time by ordering stock items.

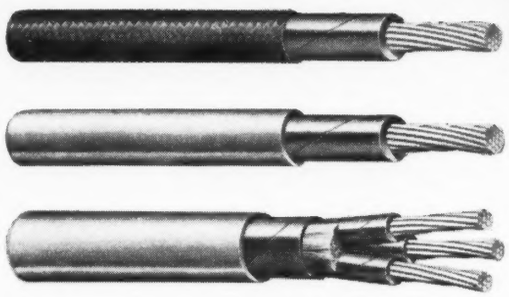
Here are four lines—selected because they have become G-E standards and are tops in their respective fields—and because we can supply some 372 different items from stock, *right off the shelf.*

There are also hundreds more—apparatus leads, switchboard wire, line wire, control cable, and others—and we'll gladly give details.

From the data shown here, you can get an idea of what are available and can judge if any of these standard items will meet your requirements. For current prices and more details, call or write the nearest G-E office or G-E distributor. Or see the new *Cable Digest,* which has application data, approximate prices, and a section, "How to Select Conductor Size," based on the 1940 N. E. Code. Ask for Bulletin GEA-3280. General Electric Company, Schenectady, New York.

SAVE TIME

1. NO. 1799 VARNISHED-CAMBRIC



A proved performer—with a 40-year outstanding service record. Excels on dielectric strength, is suited for high voltage. Cable can be operated at 85 C—on heavy currents, saves copper.

Where to use: for power feeders.

75 ITEMS IN STOCK

Single-conductor
600, 3000, and 5000 volts—braided and leaded

Three-conductor
600, 3000, and 5000 volts—leaded

2. VERSATOL* BRAIDED POWER CABLE

Insulation has a water-absorption factor of 0.010 gram per sq in.—cable needs no lead sheath. Operating temperature, 75 C—highest for rubber. Oxygen-bomb aging, 504 hours—approximates 50 years' natural life.

Where to use: for general-purpose wiring.

*REG. U. S PAT. OFF.

20 ITEMS IN STOCK

Single-conductor
600 volts, braided
(See also tellurium parkway)

SELECT STANDARDS

"It must . . . be remembered that standard lines have become standard because they have on the whole performed best . . . Furthermore, every order for special equipment, where standard would have done, takes just so much production time away from some other order that is needed for defense. Thus, specials defeat their own purpose and help to slow up the defense program."

ELECTRICAL WORLD Oct. 5, 1940

GENERAL ELECTRIC INSULATED CABLE
ALWAYS THE RIGHT TYPE FOR EACH JOB

3. FLAMENOL*—SELF-PROTECTED

An outstanding G-E synthetic-insulated cable. Needs no protective finish. Resists oil, acids, alkalies, moisture, and flame. Operating temperature, 60 C.

Where to use: for all low-voltage jobs where wiring must meet extraordinary conditions.

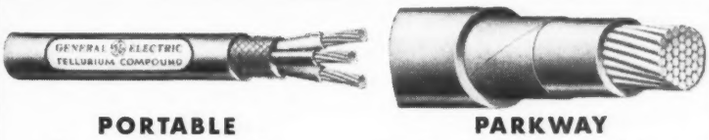
*REG. U. S. PAT. OFF

150 ITEMS IN STOCK

Single-conductor
600 volts, 12 colors. More sizes of black are carried in stock than of any other color.

4. TELLURIUM

With jacket of 60% new rubber, cured with tellurium. TOUGH—will last for years



PORTABLE
For all types of portable electric equipment

PARKWAY
For direct burial in ground, for use in ducts and in other places

76 ITEMS IN STOCK

Superflexible arc-welding cable
600 volts—single-, 2-, 3-, and 4-conductor
2500 volts and above—3-conductor, Type G

51 ITEMS IN STOCK

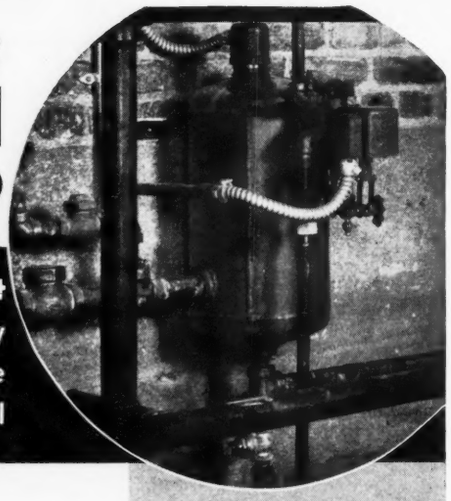
With 30% rubber or Versatol insulation
600 volts—single-, 2-, and 3-conductor
2500 and 5000 volts, single-conductor
5000 volts, 3-conductor

GENERAL ELECTRIC

502-1

Know the JOHNSON ELECTRAP

The pumping trap that offers greater reliability . . . better performance . . . new remote control



USERS of Johnson Electrap call it the pumping trap that has everything.

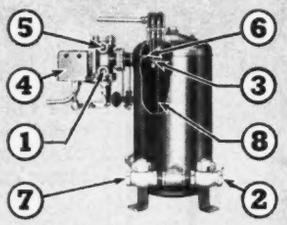
It is first of all absolutely dependable. The old mechanical system of floats and levers has given way to a modern electrical system of control. Stationary electrodes use the water in the trap to control an electric circuit to a solenoid valve, eliminating all floats, stuffing boxes, all moving parts, from the trap chamber. Operation is as dependable as the flow of electricity.

With this modern system of electrical operation the Electrap has reached new heights of performance. In many plants it has solved pumping problems that would ordinarily require steam or electric pumps, or cumbersome tilting traps. In many cases, too, it is being used to drain unusually *high* vacuum lines; one Electrap, for instance, is operating successfully under 27" of vacuum.

But perhaps the most welcome feature of the Electrap is its new remote control. Here at last is an answer for those piping layouts where a trap must be installed in some inaccessible spot. All the controlling valve gear — all the parts subject to any wear—are gathered into one compact assembly that can be mounted separate from the trap chamber, in any convenient location.

Write for new catalog. It lists sizes, shows piping layouts, to fit the Electrap into any plant.

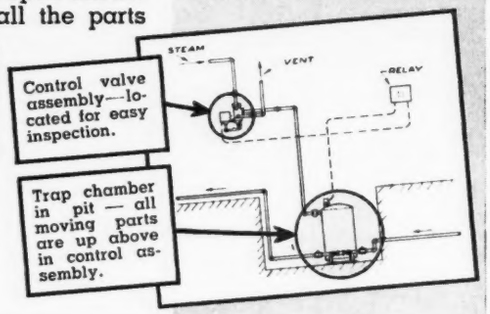
● Photo of Johnson Electrap installed in mill of the Eddy Paper Co., at White Pigeon, Mich. This unit is used to lift returns from heating equipment.



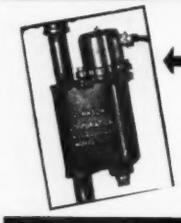
How the Electrap Works

When control valve is in normal position vent (1) is open and liquid to be lifted (or condensate) enters inlet (2). When water level in chamber reaches short electrode (3) electric circuit is completed through a relay. Relay actuates solenoid (4) which closes vent and opens inlet (5) to admit lifting or equalizing pressure to trap chamber through pipe (6). Contents of chamber are discharged through outlet (7) until water level falls below long electrode (8). Then control valve returns to normal and chamber can fill again.

MOUNT THE CONTROL VALVE ANYWHERE

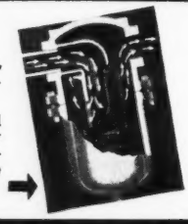

Control valve assembly—located for easy inspection.
Trap chamber in pit — all moving parts are up above in control assembly.
STEAM
VENT
RELAY

OTHER JOHNSON DEVELOPMENTS



BOILER WATER CONTROL—Dependable, low cost, easily installed automatic boiler level control. Utilizes new electrical operation.

JOHNSON-GAST SEPARATOR—Removes water and dirt from compressed air. Also available for steam service. Complete Johnson-Gast line includes Aftercoolers—cools compressor discharge to condense moisture—and Oil Absorbers.



Products of The **Johnson Corporation**

865 WOOD STREET, THREE RIVERS, MICHIGAN

municipal light and water plant. The two 363-hp engines now in use will be augmented by the 415-hp unit, driving a 300-kw generator and 7.5-kw exciter. John W Smith & Son, of Indianapolis, Ind., are consulting engineers in charge of the work.

Revere Offers $10,000 for Defense Suggestions

Revere Copper & Brass, Inc, through its president, C Donald Dallas, announces a $10,000 Revere Award for the ten best suggestions which would aid in speeding national industrial defense submitted by workers in the American metal-working industry. The first prize is $5,000, with the remainder graduated down to $250.

The Revere Award is open to wage-earners in the metal-working industry. In general, this means foremen, subforemen and working men. It is not intended for executives, engineers, laboratory technicians, metallurgists or similar personnel. According to the descriptive bulletin published by Revere, drawings, models or blue-prints are not necessary. All that is needed is a rough sketch or brief description telling about the product, process, method, tool, device, or idea. Every entry will remain the property of the sender.

Five men have volunteered to be the Revere jury to determine the winner. These are: Henry Heald, president, Illinois Institute of Technology, chairman; Admiral Joseph Strauss, U. S. Navy, retired; Major General Frank Parker, U. S. Army, retired; Robert Watt, former American labor delegate to International Labor Conference in Geneva, Switzerland; and C Donald Dallas, president, Revere Copper & Brass, Inc. Contestants must use the form provided by Revere, and all entries must be postmarked before midnight, April 30th, 1941. All entries received with a later postmark will be returned unopened. Winners receiving the awards will be announced on June 1, 1941.

Duquesne Begins New Power Station

Construction work on new $8,000,000 electric generating station of the Duquesne Light Co has been started and the 80,000 hp capacity is expected to be completed by July, 1942. The plant, to be known as the Frank R Phillips power station, in honor of the company president, will be built 20 ft above 1936 flood levels.

The new station will be located on

5 Reasons Why You Get More Pull for Your Money with *Gilmer* KABLE KORD

On any modern flat drive, if you want to be sure of maximum power transmission at minimum cost, you'll specify Gilmer Kable Kord Belts.

1 **Kable Kord increases production because the upper contactor cords make the pulling cords grip pulleys firmly. There's no slippage and no power wasted.**

2 **Kable Kord's minimum stretch eliminates any need for take-ups, saves time and permits shorter distances between pulley centers.**

3 **Flexibility provides resilience to take starting shocks repeatedly.**

4 **Kable Kord gives longer wear because of its rugged construction and lack of internal friction even at high operating speeds.**

5 **Kable Kord is available either endless or in rolls, and is adapted for use on a great many mill and shop drives, on tractors, etc.**

Take advantage of Gilmer Engineering Service and the complete line of Gilmer Belts to get smoother power transmission, more dependably and at lower cost.

L. H. GILMER COMPANY Tacony, Philadelphia, Pa.

A TRANSMISSION BELT FOR EVERY PURPOSE

THE COMPLETE GILMER LINE—BELTS FOR EVERY DRIVE

V-BELTS for either fractional or multiple horsepower use

STREAMLINER V-BELTING where there are obstructions

KABLE KORD endless and in rolls for flat belt drives

CD AND CUT EDGE FLAT BELTS for f.h.p. duty and on small machinery

RH AND RHO BELTS for lathes, grinders and milling machinery

ROUND BELTS AND BELTING for serpentine, crossed or light mule drives

SPEEDAGE ENDLESS BELTS of woven fabric for high speed work around 10,000 f.p.m.

#99 and #1010 SPLICED ENDLESS BELTS for light grinders, routers, drill presses, etc.

SPLICED ENDLESS SOLID WOVEN BELTS AND BELTING for light conveyors and light duty transmission

BAND SAW BANDS used in woodworking

SPINNER AND TWISTER BELTS used in the textile industry for spindle drives

PLANER BELTS for heavy duty lumber and woodworking equipment

GAINER, CONE AND LICKERIN BELTS for textile throwers, lickerins and spindles

PRINTERS' TAPE AND MIEHLE PRESS BELTS for printing press and paper converting equipment

LAUNDRY FEED RIBBONS for conveying laundry flat work

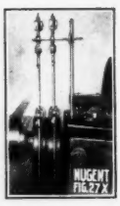
COTTON DUCK AND ENROBER BELTS for light conveyors in bakeries, candy factories, etc.

TUBE WINDER BELTS for turning paper tubes of all sizes in the container industry

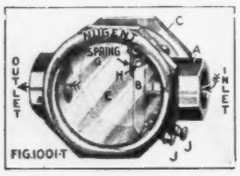
IF IT'S
a Filtering or Oiling Device,
YOU CAN GET IT AT
NUGENT'S

Sight Feed Oiler Removable glass to clean while oil is running.

Oil-From-The Floor Shaft Oiler. Fifteen feet off the floor



Telescopic Eccentric Oiler. Oil cup is stationary. Dust Proof



Sight Flow Indicators Sizes up to 5" inclusive

Pressure Oil Filters for Diesel Engine Fuel and Lube Oil. 8 Sizes from 1 to 130 U. S. g.p.m. 20 times greater filtering area. P'T'D.

Gravity Oil Filters. 24 sizes From 1 to 35 g.p.m.

Compression Pipe Fittings—No threads Saves 75% in labor and tighter joint

NUGENT TRADE MARK

SEND ME:

WM. W. NUGENT & CO., INC., EST. 1897
402 N. HERMITAGE AVE., CHICAGO, ILL.

Please send me literature and quotations on following items:

☐ Fig. 80 N ☐ Fig. 571 ☐ Fig. 27 X
☐ Fig. 1001 T ☐ Fig. 1116 HA ☐ Fig. 1116 SV
☐ Fig. 1116 NC ☐ Fig. 970 A ☐ Fig. 713 A

Name .....

Company .....

Street .....

Town ..... State .....

the Ohio River on a 50-acre site recently purchased. The first installation will be laid out so that additional generating units may be added, up to a maximum capacity of 350,000 hp. When the station is completed it will bring the total system capacity to 832,000 hp.

Central Maine Builds

Central Maine Power Co plans construction of new power station, location to be determined in the near future. Equipment for the new station is already on order. Initial capacity will be approximately 27,000 hp capacity, with an ultimate capacity of 150,000 hp.

The turbine will operate at 600 lb steam pressure, 750 F superheat. The station will be tied in with present transmission lines of the company, including those of a hydro station. New station power will be used mainly as filler between hydro output during low-water periods.

Penn Power Co Adds 35,000 Kw

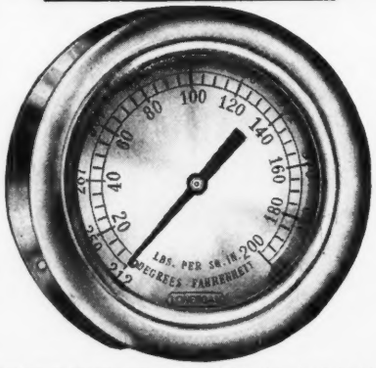
Generating capacity of Pennsylvania Power & Light Co will be increased 35,000 kw as a result of the new $5,000,000 expansion program at the company's "mine-mouth" steam-electric plant located at Hauto, near Mauch Chunk, Pa. The company recently placed an order with Westinghouse Electric & Mfg Co, for the high-pressure topping turbine. This will increase the capacity of Hauto to 110,000 kw when it goes into operation late in 1942.

Plans also provide for the installation of two new boilers, operating at 1325 lb pressure and 930 F. Each boiler will make 350,000 lb of steam per hr, and will be pulverized-coal-fired.

BUSINESS ITEMS

American Locomotive Co announces two changes in personnel. Joseph B Ennis has been appointed senior vice-president and resigns his former position as vice-president in charge of engineering. Mr Ennis is a director of the American Locomotive Co and a director of the Federation Bank & Trust Co, New York. James P Davenport has been appointed vice-president of engineering, development and research, succeeding Mr Ennis. Mr Davenport left the New York Central Railroad to become assistant vice-president of American Locomotive, which position he held until his present appointment.

Lonergan



PYROMETER STEAM GAUGE

Used to indicate pressure of steam per square inch and corresponding degrees of heat

MODEL GF

Graduated in degrees Fahrenheit (unless otherwise specified) and graduated to desired maximum pressure. Details and prices on request; write—

J. E. LONERGAN CO.
Race & Second Streets, Philadelphia, Pa.

Lonergan
GAUGES · VALVES · SPECIALTIES

300 SPECIALTIES for POWER PLANTS—SINCE 1872

HERCULES
Seamless Copper
FLOATS

GUARANTEED TO STAND UP!

Every Hercules Float carries our guarantee to stand up under 350 lbs. working pressure and 500 degrees temperature.

Fabricated of seamless copper under our special spinning process. Hercules Floats are uniform in thickness and high in mechanical strength.

You can depend on Hercules for floats—in standard shapes up to 10 in. and in special types to your specifications—to give long, dependable, economical service.

Insure care-free maintenance of water level in your heaters, tanks, reservoirs and other equipment by specifying "HERCULES."

HERCULES FLOAT WORKS
200 Franklin St.
SPRINGFIELD, MASS.

The Direct Way

AN ALL-ELECTRIC ADJUSTABLE-SPEED DRIVE FOR A-C CIRCUITS

Speed Ranges up to 16 to 1 — Sizes 1 to 30 hp.

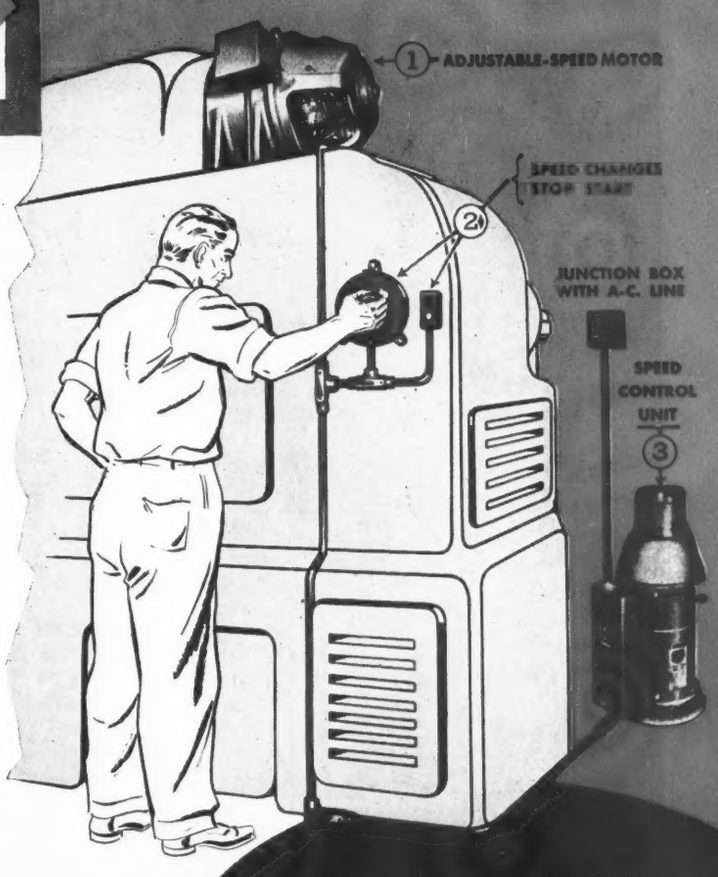
RELIANCE V★S DRIVE

THE V★S way shortens the distance from power to work. It's the direct way, eliminating intermediate speed-changing devices, clutches, gear trains, a multiplicity of handles and knobs. It makes full use of the electric motor as a simple speed-changing device as well as a power unit (1).

From one handle in a convenient spot speeds are changed smoothly over ranges up to 16 to 1 while the machine is running. To stop, press a button; to start again, press another and the machine comes back to its previous speed (2).

And here are more features that help step up production: quick stopping, reversing, safe speeds for threading and inching, ample starting torque with smooth acceleration.

Using a proven principle of speed control, the Reliance V★S Drive now gives you these many advantages at a new low price. This is possible because of the packaged speed control unit (3) which is connected by three wires to a 3-phase a-c. power circuit. It takes little space and can be mounted anywhere.



RELIANCE ELECTRIC & ENGINEERING COMPANY

1088 Ivanhoe Road • • • Cleveland, Ohio

BIRMINGHAM • BOSTON • BUFFALO • CHICAGO • CINCINNATI • DETROIT • GREENVILLE (S. C.)
HOUSTON (TEX.) • LOS ANGELES • NEW YORK • PHILADELPHIA • PITTSBURGH • PORTLAND (ORE.)
ST. LOUIS • SAN FRANCISCO • SYRACUSE (N. Y.) • AND OTHER PRINCIPAL CITIES.

CONVENIENCE, WITHOUT LIMITATIONS

The start-stop button and speed changer can be placed anywhere that you can run a wire. Grouped with other control elements for the machine they make centralized control complete.

Get Bulletin 309 for details.

RELIANCE A-C D-C MOTORS

SAVE AIR SAVE DOLLARS
WITH
ROCKWELL BLAST GATES
FOR LOW PRESSURE AIR

SLIDE TYPE
BUTTERFLY TYPE
KWIKLEEN TYPE
WAFER BUTTERFLY TYPE

Butterfly Flanged Type

Write for Catalog No. 3760

W. S. ROCKWELL CO., 50 Church St., New York

SAVE TIME, TUBES AND MONEY — USE WILSON TUBE CLEANERS

For efficiently and economically cleaning any ferrous or non-ferrous tube or pipe that can be cleaned mechanically, a Wilson tube cleaner, cutter head, brush or other accessory does a better, faster job—whether the tube be straight or curved—of large or small diameter.

The severest operating conditions quickly prove the outstanding qualities of Wilson tube cleaning equipment.

Write for the name of our representative nearest to you or send for a copy of our new thirty-six page catalog fully describing and illustrating the complete line of Wilson tube cleaning equipment.

THOMAS C. WILSON, Inc.
PIPE AND TUBE CLEANERS EXCLUSIVELY
47-28 37th Street Long Island City, N. Y.

CARBORUNDUM Co is celebrating the 50th anniversary of its founding by publication of commemorative brochure describing discovery of Carborundum and formation of company by Edward G Acheson. Booklet tells story of first use of abrasive, establishment of plant at Niagara Falls, and uses of abrasive today.

Charles Cook and W A Sumner have been appointed manager of steam service and manager of distribution transformer engineering respectively, of WESTINGHOUSE ELECTRIC & MFG Co. Mr Cook will make his headquarters at the South Philadelphia Works, while Mr Sumner will take up his duties at Sharon, Pa.

This year marks the completion of 75 years of service by the VALVOLINE OIL Co, Cincinnati, Ohio. Parent organization was launched in 1866 by Dr John Ellis, a Michigan homeopathic physician who became interested in Pennsylvania Petroleum products during the Civil War. Dr Ellis organized the Continuous Oil Refining Co, which later changed its name to Leonard & Ellis and then to Valvoline Oil Co to distill and market what was then known as "rock oil." At that time steam-cylinder lubrication was accomplished by means of tallow, suet, lard or compounds of vegetable or animal origin. The new petroleum cylinder oil was introduced but not widely used until George Corliss adopted it for use in his engines.

COOPER-BESSEMER CORP announces resignation of B B Williams as president and election of Charles B Jahnke as his successor. Mr Williams was made chairman of the Board of Directors and expects to continue in an active capacity as head of the corporation. Mr Jahnke, who has been vice-president and general manager of the company for the past 2½ years, will act as president and general manager, and will serve as a member of the executive committee.

MONSANTO CHEMICAL Co, St. Louis, Mo., announces promotion of Daniel S Dinsmoor, manager of Illinois plant, to assistant general manager of Organic Chemicals Div of the company. Succeeding him as plant manager is William G Kummrich, who has been manufacturing superintendent of that operation. In addition, promotions of Samuel Cottrell, assistant manufacturing superintendent, and Robert M Sanford, supervisor, to manufacturing superintendent for inorganic and organic chemicals, respectively, were announced.

MONEY-SAVING IDEAS

for EQUIPMENT BUILDERS

Nickel Cast Iron News
Published in the Interest of Producers and Users of Cast Iron
Orientals Make Good Use of Alloy Iron Castings
New Abrasion Service Records Made Available
Nickel Steel Topics
Published in the Interest of Producers and Users of Nickel Alloy Steels
Screwdrivers Made to Withstand Rough Treatment
Nickel Steels Play Important Role in Machine Tools
"Bicycle Built for Two" (Speeds)

Two periodicals mailed FREE on request, cite actual cases

NICKEL STEEL TOPICS—This twelve page illustrated, miniature newspaper is published every second month and is devoted exclusively to Nickel alloy steels. Each issue is packed with illustrated technical and news articles dealing with the production, treatment and uses of these steels in rolled, forged and cast forms. Special features such as a question and answer page and pertinent editorials on technical subjects involving the uses of Nickel alloy steels are included in every issue.

NICKEL CAST IRON NEWS—This publication is a 12 page, illustrated newspaper-type periodical devoted to technical and news articles featuring the production of Nickel cast irons. Editorials and a question and answer section on these materials are special features in each issue. "Nickel Cast Iron News" alternates on a monthly basis with "Nickel Steel Topics".

NICKEL STEELS • CAST IRONS

AVAILABLE ON REQUEST—More Than 75 Publications Covering Various Industrial Fields, Applications and Production Procedures.

Permanently valuable for reference purposes are a large group of publications applying to various industrial applications and production procedures involving the uses of Nickel alloy steels, Nickel cast irons or Nickel containing non-ferrous materials. The titles of these publications with a brief description of their respective contents are set forth in a special catalogue, available on request. For your copy, simply return the coupon below.

The factual, informative material appearing in "Nickel Steel Topics" and "Nickel Cast Iron News" is of considerable practical value as evidenced by the fact that over 100,000 engineers, metallurgists and production men are now regularly reading these publications. You may read them too, at no cost or obligation. Simply mail the coupon at right.

I'D LIKE TO KEEP UP WITH THE NEWS

The International Nickel Company, Inc., 67 Wall St., New York, N. Y.

Gentlemen: Without cost or obligation, please send me the publications checked:

Nickel Steel Topics ☐ Nickel Cast Iron News ☐ List of Current Publications ☐

Name _____

P.2-41

Address _____

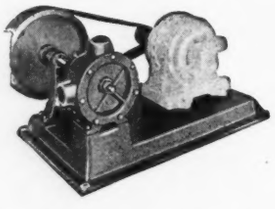
City _____ *State* _____

THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET NEW YORK, N. Y.

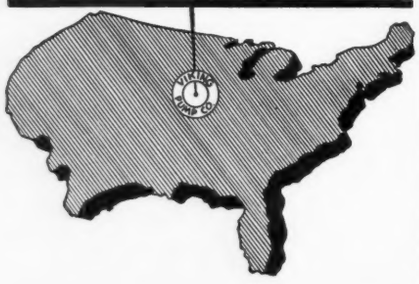
VIKING

NATION-WIDE IN SALES and SERVICE

Full-speed ahead, America . . . and Viking is all set to go. Major Distributors are strategically located in every important production center of the nation — Sales and Service Offices blanket the country. With the most complete selection of stock rotary pumps in the world, Viking is prepared to ship promptly. For a copy of Bulletin 1802-35, listing full technical data on Auxiliary Power Pumps, contact the nearest Viking Representative or write the Viking Factory direct.



Viking Sales and Service Offices: Chicago, Cleveland, Indianapolis, Los Angeles, Kansas City, Milwaukee, Minneapolis, New York, Baltimore, Boston, Buffalo, Cincinnati, Denver, Albuquerque, Billings, Omaha, Detroit, Houston, Dallas, Memphis, New Orleans, Philadelphia, Pittsburg, Richmond, San Francisco, Seattle, Portland, St. Louis, Tulsa.



VIKING PUMP CO.

CEDAR FALLS, IOWA

Henry M Hale, eastern sales manager of Caterpillar Tractor Co, announces his resignation from that office to enter partnership with John R Taylor, as TAYLOR-HALE MACHINERY CO of Memphis, Tenn. From its headquarters in Memphis, the newly-formed company will handle sales and service of "Caterpillar" products in a southern area.

A C HARVEY CO, Allston, Mass., identified for years with sales of steel products and welding equipment in New England, have been appointed jobbers of line of Hobart arc welders, to collaborate with Leo Gordon of Hobart Mfg Co, New England distributing office.

At its annual meeting on December 2, 1940, HYDRAULIC INSTITUTE, national association of pump manufacturers, presented three awards to winners of first annual Engineering Essay contest. First prize was awarded to I J Karassik, Worthington Pump & Machinery Co, for his paper, "Thermodynamics of Boiler Feeding." Prizes were also presented to Hans Gartmann and Hollis T Waldo for their papers, "Operation of Centrifugal Boiler Feed Pumps," and "Submergence for Centrifugal Condensate Pumps."

BLACK, SIVALLS & BRYSON, INC, Kansas City, Mo., have recently opened an office at 30 Rockefeller Plaza, New York, N. Y., to handle local sales and service. T S Murphy is in charge.

Addison Vars and Edward H Townsend were elected president and executive vice-president and treasurer of the STERLING ENGINE CO, respectively. Spencer H Logan, president since 1939, was elected chairman of the board, succeeding Charles A Criqui, who in turn became vice-chairman. Membership of the board was increased from five to seven, the new members being Mr Townsend and Frank G Raichle, who was subsequently elected secretary.

BOSTON WOVEN HOSE & RUBBER CO announces a new process for continuously vulcanizing belts, eliminating press overlaps. Process, called BWH Rotocure Process of Continuous Vulcanization provides continuous uniform stretch, before vulcanization, and continuous uniform cure after.

CHELSEA FAN & BLOWER CO announces expansion to new quarters. Effective Feb. 1, new address is Olsen & Grove St, Irvington, N. J. Address was formerly 370 West 15th St, New York.

When you need grates

Specify **BATES**

FOR LONG-TIME ECONOMY

FILLET WELD

BATESGRATES

—One Piece Construction

Each intersection, and consequently, each complete panel of Batesgrates, is strictly one piece. Non-slip, sharp top edge, self cleaning cross bars like the ridge of a roof. No cracks, joints, or acute angles. No grooves to hold grease and dirt and create slippery spots. Batesgrates are an engineered assembly of bars—all bars work.

Write for engineering Catalog No. 937.

WALTER BATES COMPANY

208 S. LaSalle St. Chicago, Ill.

WATER REFINING EQUIPMENT HEADQUARTERS

INDUSTRIAL—PROCESS
RAILROAD—MUNICIPAL—HOUSEHOLD

✓ **FILTERS** Of All Types and Capacities . . . Gravity . . . Pressure

SOFTENING SYSTEMS ✓ All Types and Capacities—Zeolites (synthetic and natural) and Lime and Soda

CHEMICAL FEEDERS ✓ (wet or dry) Acids . . . Hypochlorites . . . Alkalies

EQUIPMENT for REMOVAL Of Iron . . . Tastes . . . Odors . . . Colors . . . Suspended Matter

SWIMMING POOL EQUIPMENT ✓

AERATORS • DE-GASIFIERS

WATER TEST SETS ✓

RE-CARBONATORS ✓

The **AMERICAN WATER SOFTENER COMPANY**

WATER REFINING EQUIPMENT HEADQUARTERS

INDUSTRIAL • PROCESS • RAILROAD • MUNICIPAL HOUSEHOLD, ETC.

322 LEHIGH AVE., PHILA., PA.

Boiler tube users save up to 30% IN INSTALLATION COSTS

You, like many other boiler tube users, can probably effect substantial savings in installation costs by changing to Republic ELECTRUNITE Tubes.

Users whose total footage installed runs into the millions of feet have reported savings ranging up to 30% of former costs. Here are the reasons:

Republic ELECTRUNITE Tubes are consistently uniform — in diameter, concentricity, wall thickness, hardness, ductility, strength and smooth scale-free surface. They slide through tube sheet holes without difficulty, even when holes are drilled to close tolerances. They expand, prosser, roll in, bead and weld easily and smoothly. They expand evenly to a tight fit — reduce the danger of over or under rolling — reduce necessity for rerolling leaking joints after test. They are highly ductile and free from hard spots. And the surface is free from scale and scale pits — as smooth as glass. No pickling is necessary.

Republic ELECTRUNITE Tubes are thoroughly tested and inspected to insure safe, sound boilers free from tube troubles for a long time to come. Thus, they also can save you money by reducing maintenance expense.

Make a note right now to investigate Republic ELECTRUNITE Tubes — and do it before you have another boiler to build or repair. You can obtain all the facts — and figures — promptly by writing Steel and Tubes Division, Republic Steel Corporation, Cleveland, Ohio.

REPUBLIC

REG. U. S. PAT. OFF.

ELECTRUNITE

ELECTRIC RESISTANCE WELDED BOILER, CONDENSER AND HEAT EXCHANGER TUBES

YOUR No. 1 OPPORTUNITY

With industry speeding up to cope with plans for national defense, it is time to step up the efficiency of your power producing equipment to its maximum. That is a job for the most effective INSULATION available. Nominated for that job is the ideal maintenance insulation—

BH No. 1 Insulating Cement

A plastic material easily applied to large and small equipment of odd and irregular shapes as well as flat surfaces. EFFECTIVE UP TO 1800° F . . . 100% reclaimable up to 1200° F . . . Exceptionally high coverage . . . Low volume shrinkage . . . Packed in 50 lb. bags, it presents no storage or breakage problems.

Write for Complete Information to

BALDWIN-HILL CO.

575 Klagg Ave. Trenton, N. J.

Branch Offices in:
NEW YORK BOSTON CHICAGO
KALAMAZOO, MICH.

Enco Burners

. . . . for the efficient combustion of all grades of

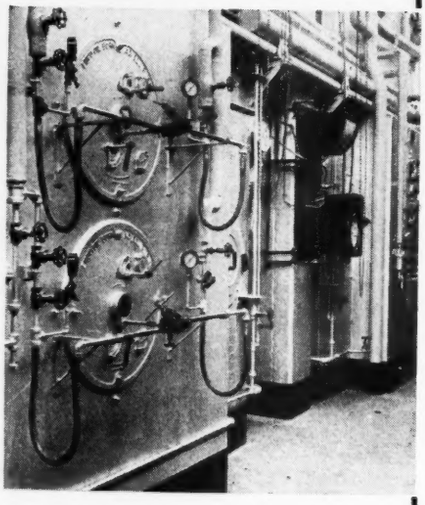
OIL, TAR or GAS

Burner Units of Steam or Mechanical Atomizing Types in various sizes with capacity ranges of from 1 to 1000 gals. per hour.

Designed for operation either with or without air register for natural or forced draft.

The ENCO Interchangeable Oil Burner is designed for instant change of atomizer gun for operation by either steam or mechanical (pressure) system or to cover a wide range of capacity.

ENCO Oil Atomizers are being applied to various types of standard pulverized coal and gas burner units to provide a dual fuel unit for cold starting or for full load operation when coal or gas is not available or when oil is the more economical fuel.



We have made many installations and would be glad to cooperate with those looking for better operation and assurance against loss of steam output.

Write for Bulletin OB-40 and 37 describing ENCO Oil Burning, Pumping and Heating Equipment.

THE ENGINEER COMPANY

75 West St., New York, N. Y.

Current Comment

(*Continued from page 122*)

The writer has been studying exactly this same problem for many years, and has considered practically every solution offered in the many replies to this question.

However, about one year ago, I discovered a device already on the market which I believe to be superior to any suggestion offered in POWER of September, 1940. This device is manufactured by the Moto Meter Gauge & Equipment Div. of the Electric Auto-Lite Company, 844 N Rush St., Chicago. It consists of a mechanical industrial thermometer, having two hands. One hand is directly actuated by the thermometer element, while the other hand is a "maximum" hand, and is pushed upward on the scale by the active hand. When the temperature recedes, the active hand recedes, but the maximum hand "stays put". An electric contact is actuated by the maximum hand, so that when the maximum hand is pushed up to a temperature of 200 F, an electric contact is closed and an alarm or other device is actuated thereby. The maximum hand can be reset to 0 or any desired location manually, at will.

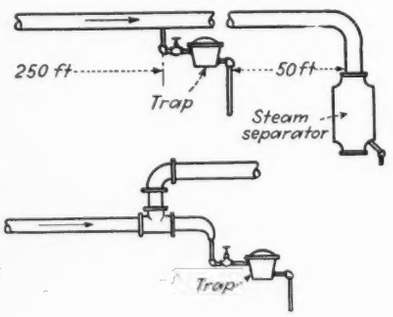
This device has the advantage in that the operator in charge can, at a glance, determine whether the bearing with which it is associated, *has been running* at a high temperature; whether the high temperature exists at the moment, or not. The maximum hand can in this manner indicate to the operator bearings which are in need of attention and can, in most instances, forestall an actual failure or shut down of the machine, on account of a hot bearing.

We use these devices in a pumping station we built about one year ago, there being one such device for each bearing. The electric contact is associated with the automatic control equipment so that if any bearing reaches a temperature of 200 F, the pump associated therewith is immediately shut down.

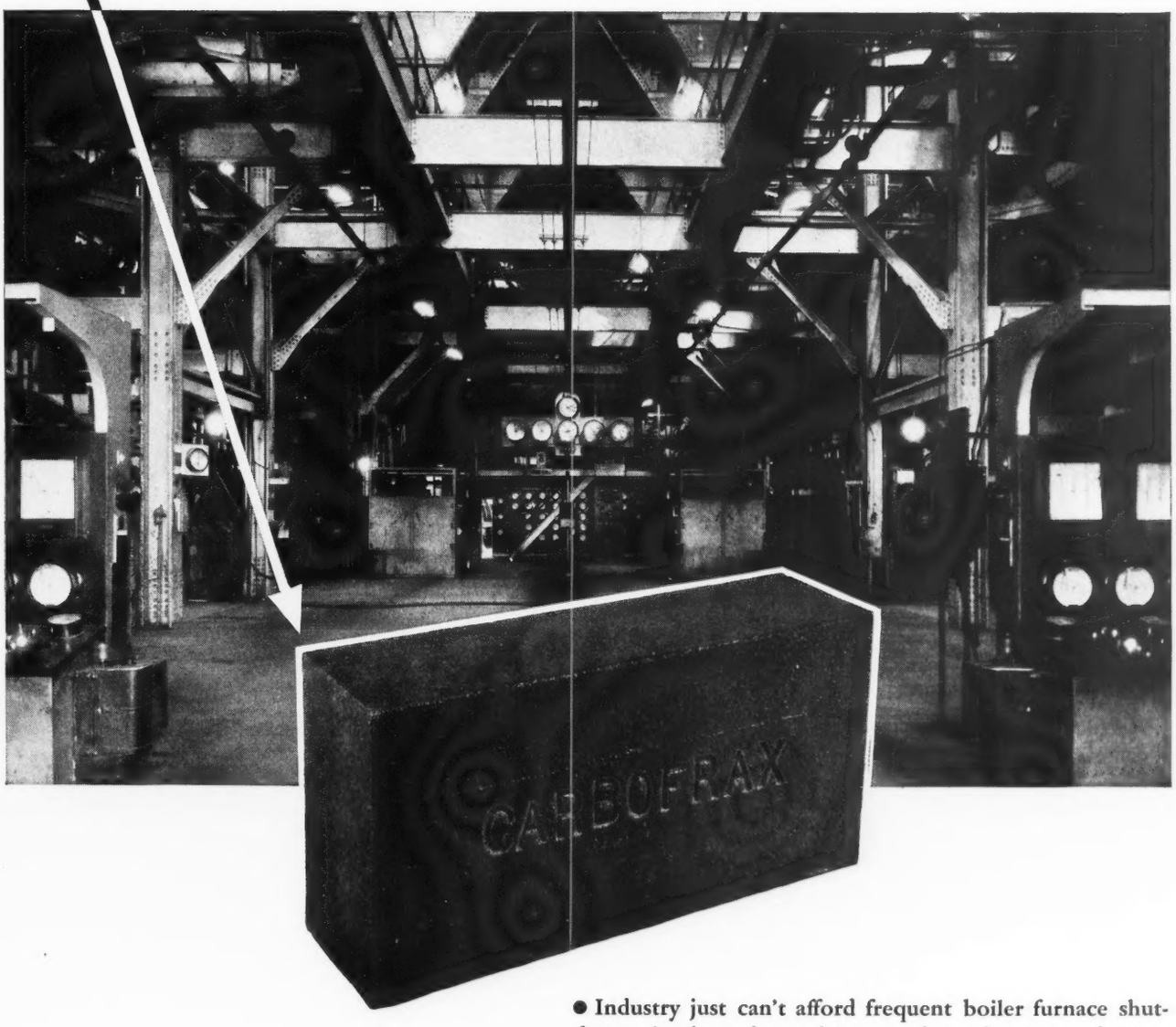
Kalamazoo, Mich EARL E NORMAN
General Supt, City Water Dept

Removing Condensate from a Steam Line

IN YOUR NOVEMBER ISSUE, DLW advises the installation of a trapped drain outlet in the steam line to an engine, as shown below. There seems to be a quite general delusion, almost amounting to a superstition, that an outlet of this kind, will effec-



HOW TO AVOID COSTLY FURNACE SHUTDOWNS



● Industry just can't afford frequent boiler furnace shutdowns in these days of increased production and plant expansion. It is vitally important that boiler furnaces for power and steam generation be kept operating continuously and efficiently.

One way to insure continuity of operation is to use "Carbofrax" the Carborundum Brand Silicon Carbide Super Refractory, along the clinker line on side walls, in front and bridge walls and for refractory protection of water walls. "Carbofrax" does not spall or soften—it eliminates clinker adhesion—it prevents frequent costly delays due to lining failures.

There are enough headaches in maintaining and increasing production schedules without worrying about your boiler settings. Call the nearest listed refractory representative for a recommendation. Remember—"A 'Carbofrax' setting is a dependable setting".

REFRACTORY CARBORUNDUM PRODUCTS

THE CARBORUNDUM COMPANY
REG. U. S. PAT. OFF.

Refractory Division, **PERTH AMBOY, N. J.**

District Sales Branches: Chicago, Philadelphia, Detroit, Cleveland, Boston, Pittsburgh. Distributors: McConnell Sales and Engineering Corporation, Birmingham, Ala.; Christy Firebrick Company, St. Louis, Mo.; Harrison & Company, Salt Lake City, Utah; Pacific Abrasive Supply Company, Los Angeles, San Francisco, Calif.; Denver Fire Clay Company, El Paso, Texas; Smith-Sharpe Company, Minneapolis, Minn.

Carborundum and Carbofrax are registered trade-marks of and indicate manufacture by The Carborundum Company

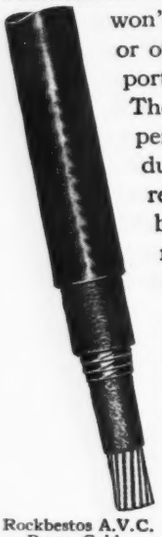
You Can

STOP THIS WALKOUT!

Any *day* . . . any *hour* . . . any *minute*, your machines may stop running, operators may walk out, production may take a nose-dive — and *wire-failure* can bring the whole trouble-making mess down on you a lot quicker and easier than agitators!

But don't let it get you down — because you can stop that kind of trouble before it starts by wiring your power and control circuits, and motors, too, with Rockbestos permanently insulated wires — resistant to heat, moisture, alkalies, caustics, corrosive fumes, oil, grease and even fire.

Every one of the 118 different wires, cables and cords in the Rockbestos line was designed to replace a wire that was failing too often under severe operating conditions. And every one of them made good in wire-wrecking installations because their insulation won't dry out or crack under heat, won't flow, swell or rot when attacked by oil, grease or other destructive agents and won't burn or support flame.

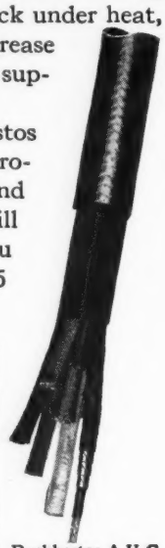


Rockbestos A.V.C. Power Cable 600 to 8000 volts AWG No. 18 to 1000 MCM

These are a few of the reasons why Rockbestos permanently insulated wires will keep your production flowing, prevent machine outage and reduce maintenance expense. Our catalog will bring the rest and show you the wires you need. Rockbestos Products Corporation, 986 Nicoll St., New Haven, Conn.

TEN TESTED ROCKBESTOS VALUES that will pay you dividends

1. HEATPROOF
2. FIREPROOF
3. PERMANENT
4. Lower maintenance cost
5. Resists heat and vibration
6. Saves work
7. Oil, Grease and Moisture resistant
8. High overload capacity
9. Permanently flexible
10. Greater carrying capacity



Rockbestos A.V.C. 600V Control Cable AWG No. 9–19/22 and AWG No. 12–19/25

Also refer to McGraw-Hill Electrical Buyers Reference.

New York Pittsburgh Buffalo St. Louis Los Angeles Cleveland San Francisco Detroit Portland, Ore. Chicago Seattle

Rockbestos A.V.C. Motor Lead Cable for 600 volt service in sizes No. 18 AWG to 1,000,000 CM — one of 118 different permanent insulated wires and cables.

tively drain the water of condensation, out of rapidly flowing steam.

If we assume that the steam is flowing at a rate of between 5000 and 6000 fpm, we have a speed in the neighborhood of a mile a minute. If we had air in the pipe, instead of steam, we would immediately recognize the fact that we had a wind blowing at nearly hurricane velocity. When we consider that the condensation occurs all around the inner surface of the pipe, it becomes clear that steam, air, or any other gas, flowing at anything like this speed, would sweep the condensation off and carry it in suspension. Then too, even if it were possible for some of the moisture to accumulate at the bottom of the pipe, its speed would be so great that most, if not all of it, would jump across any reasonably sized hole which might be cut in the bottom of the pipe.

Of course, a drain of this kind will take care of any condensation which may accumulate when steam is not flowing. It is this fact, no doubt, which misleads so many people.

To get the water out of rapidly flowing steam, we must either have a steam separator, or a piping connection which will, to some extent at least, serve the same purpose, such as that shown in Fig 2. This changes the direction of the steam flow, and at the same time, provides a reasonable probability that a considerable part of the entrained water will continue on in a straight line, and be discharged through the trap.

In the particular case under discussion, such a connection would entail something in the nature of a major operation, so it would appear that the best bet is either to see if the present separator can be made to operate effectively, or to install one that will.

Bloomfield, N. J. J O G Gibbons

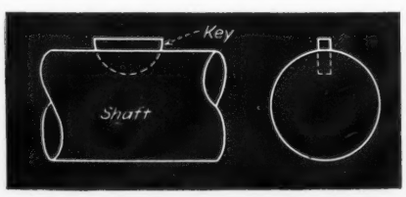
Questions for Boiler-Room Engineers

Q—What is the dangerous section when a bolt is tightened under load?

A—The section across the body, flush with the under side of the head.

Q—Sketch or describe a Woodruff key.

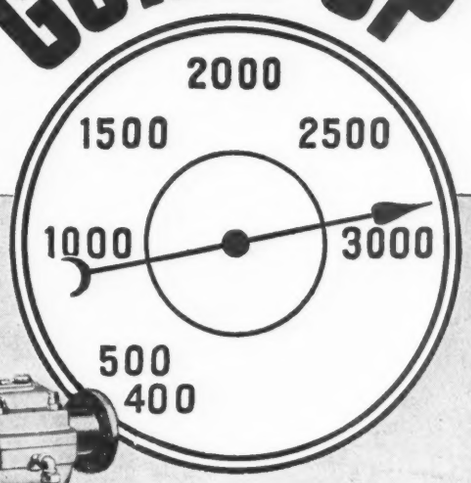
A—The diagram shows such a key:

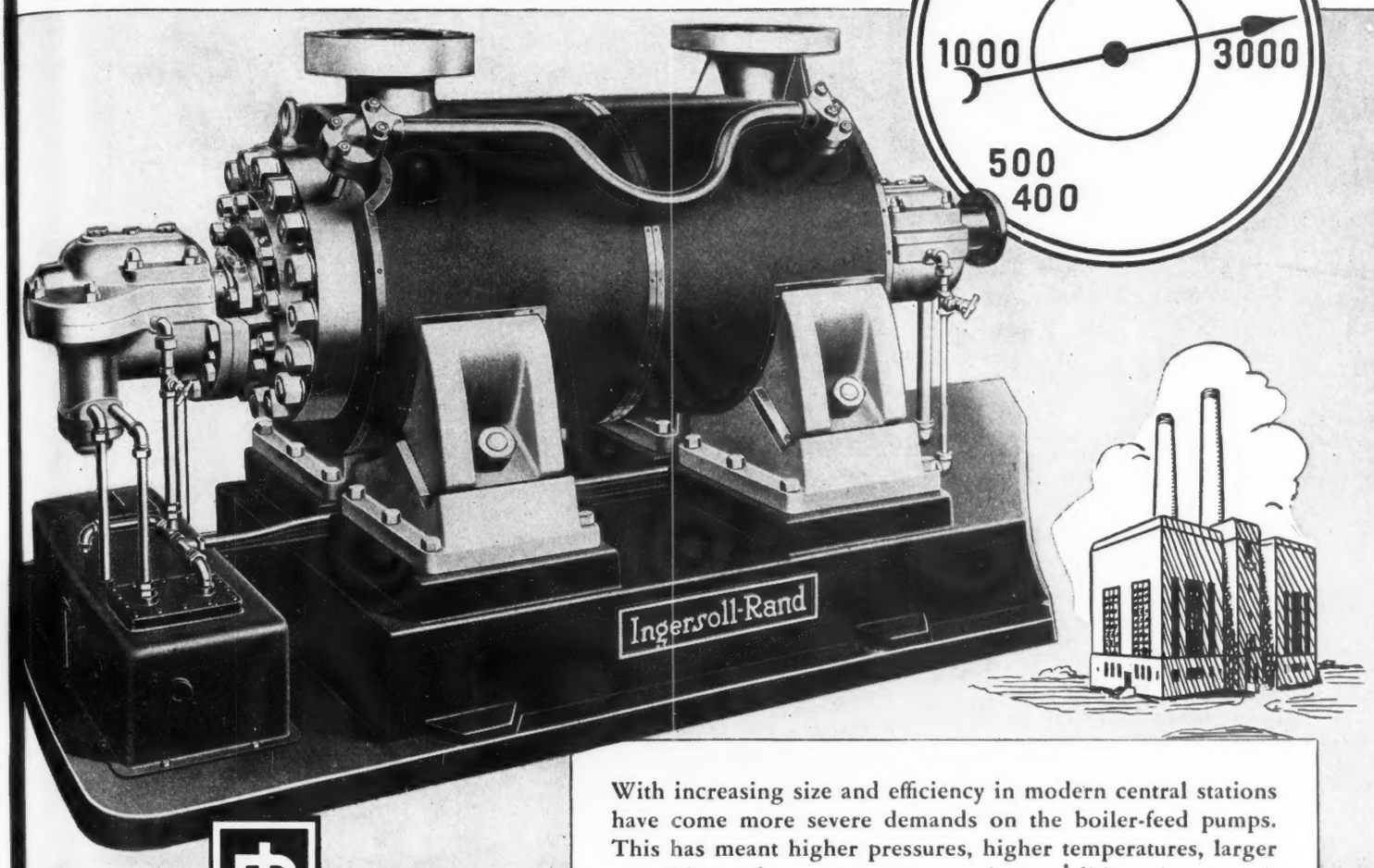


Q—If a hole is to be tapped in aluminum for a tap bolt or cap screw, is the USS or the SAE thread preferable? Why?

A—The USS thread is to be preferred for this job. It is a coarser thread than the SAE and thus will be less likely to

BOILER PRESSURES GOING UP





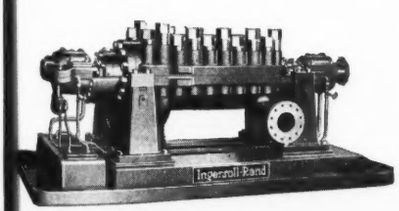
With increasing size and efficiency in modern central stations have come more severe demands on the boiler-feed pumps. This has meant higher pressures, higher temperatures, larger capacities and more severe operating conditions in general.

s CHT barrell-type
er feed pump.

● The record of Ingersoll-Rand pumps over a long period of years in boiler-feed service is unmatched for reliability and efficiency.

In 1913 Ingersoll-Rand built their first multi-stage centrifugal boiler-feed pumps to deliver 175 lbs. pressure. In 1939 they built pumps to deliver 2800 lbs. pressure for the highest pressure steam plant in the country. Whenever a more efficient or higher pressure pump has been required Ingersoll-Rand has been ready to produce it.

Class HT boiler feed pump.



Ingersoll-Rand's long experience in the field and its exceptional manufacturing, metallurgical and test facilities are assurance that your pump will be of the highest quality.

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8 Facts About

HENSZEY
BOILER FEED WATER METERS

1 They are placed right in the pressure side of the feed line.

2 They accurately, and continuously, measure the pulsating discharge of reciprocating pumps.

3 All moving parts subject to wear are easily replaced.

4 The entire mechanism can be removed from the meter without removing the body of the meter from the line.

5 As the entire inside of the body is finished, any mechanism will give identical readings in any body, making replacement an easy matter.

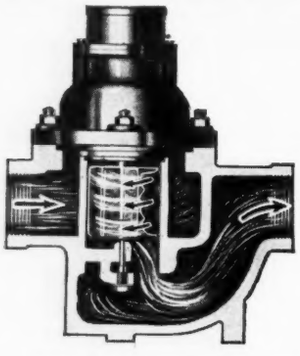
6 As the operation of the meter is not dependent upon close clearances at any point, it is not affected by the heat or dirt content of the water.

7 Meters can be calibrated to read in Gallons, Pounds, or Cubic Feet, at any specified temperature.

8 The Hydraulic Laboratory of the University of Wisconsin reports that: "The Henszey Meter is the most remarkable meter in performance and accuracy of any orifice type meter tested in the Hydraulic Laboratory."

Send for Literature

HENSZEY COMPANY
Dept. D2 Watertown, Wis.



Water enters the measuring chamber tangentially, spinning in the chamber as it passes through, forming a vortex. Each gallon that passes through this chamber makes the same number of revolutions of the water. A vane is placed in the rotating water to impart this rotation to the register. No close clearance—less wear—continued accuracy.

HENSZEY
POWER PLANT SPECIALTIES

tear in the cutting. Also, the chips will clear themselves from the tap better.

Q—Under what conditions should a globe valve be used in preference to a gate valve?

A—Normally, gate valves meet the need for a positive stop valve while globe valves are used where flow control is desired. Because of the internal design of the globe valve, its use is more or less restricted to fluids that are comparatively free from suspended solids.

Q—What velocity in feet per minute is a reasonable one for dry saturated steam flowing in a pipeline from a boiler to a reciprocating engine?

A—A reasonable velocity would be 7000-8000 ft per min.

Q—How are air compressors used in a heating system?

A—In heating systems with pneumatic controls, air pressure, supplied by a compressor, actuates valves, damper motors, etc, as directed by the primary control.

Q—What is a "degree-day"?

A—"Degree-day" is a term used in measuring building-heating loads and represents the difference between the average daily temperature and 65 F when the outside temperature is less than 65F. For example, if the average outside temperature for a given day is 55 F, then $(65 - 55) \times 1 = 10$ degree days. If the temperature for the next day is 58 F, then the number of degree days for that day would be 7, and for the two days would be 17. Degree-days for the months of the heating season and for the total season are regularly published for most cities and towns. This data simplifies heating calculations particularly where fuel consumption for a heating season or some similar figure is to be estimated. In a typical heating season in New York, about 5300 degree-days will be registered.

Q—Name two methods by which high-pressure steam may be made suitable for use in a low-pressure heating system.

A—By expansion through engine or turbine, or passing through a reducing valve.

Q—What, if any, would be the objections to pumping refrigerated water through the radiators of a heating system during hot weather, thereby making large buildings more comfortable during the summer at a relatively slight cost for the distribution of the cooling medium?

A—The radiating surface would be inadequate.

MEETINGS

American Society of Mechanical Engineers—*Spring Meeting, March 31–April 3, Atlanta, Ga. C E Davies, secretary, 29 W 39 St, New York, N. Y.*

American Society for Testing Materials—*1941 Spring Meeting and Committee Week, March 3–7, Hotel Mayflower, Washington, D. C.*

Midwest Power Conference—*Fourth Annual Meeting, Palmer House, Chicago, Ill. April 9–10. Charles N Nash, conference secretary, Illinois Institute of Technology, Chicago, Ill.*

National District Heating Association—*Annual Meeting, June 10 to 13, 1941, William Penn Hotel, Pittsburgh, Pa. John F Collins, Jr, secretary-treasurer, 1231 Grant Bldg, Pittsburgh, Pa.*

"STANDCO" PILLOW BLOCKS

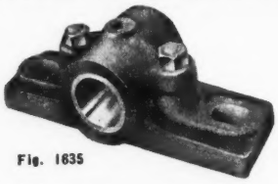


Fig. 1635

Combining clamp block and pillow block requirements in one type, the "Standco" shown above is sturdily built and is offered in a wide range of sizes. Babbitted bearing surfaces are finished beautifully smooth, both faces machined. It can be depended on for long, trouble-free service.

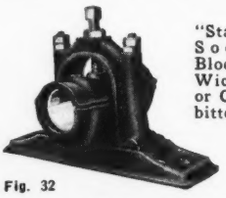


Fig. 32

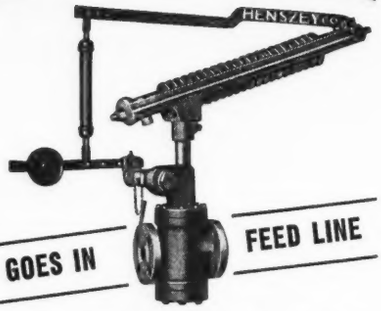
"Standco" Ball and Socket Pillow Block, Ring or Wick Oiling, Plain or Collar End Babbitted Bearings.

Write for Bulletin

STANDARD PRESSED STEEL CO.
JENKINTOWN, PENNA

Boston Chicago
Detroit Box 577 St. Louis
Indianapolis San Francisco

HENSZEY
BOILER FEED REGULATORS



The Henszey Boiler Feed Regulator controls boiler water levels continuously and accurately under *all* load conditions!

These simple, compact, self-contained units go right in the feed line and require no additional structural support. They are as easy to install as a simple gate or globe valve. Once installed and set for operation no further attention is necessary — nothing to get out of order — nothing to reset.

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Dept. D2—Watertown, Wis.

Replace Gaskets Quickly and Easily

with

FLANGE-JACKS!

TO OPERATE FLANGE-JACKS:
Remove opposite flange bolts, insert jaws of Flange-Jacks in holes and tighten. After removing other bolts, tighten down jack-screws together, separating flanges evenly.

GASKETS on existing pipe lines can be quickly and easily renewed with Flange-Jacks—a specially designed tool recently introduced by Garlock.

No hammers . . . no chisels . . . no wedges . . . no broken flanges . . . no damaged faces . . . no pipe vibration . . . no dangerous sparks . . . no long shut-downs.

You just let Flange-Jacks do the work. Even if a joint is located where working space is cramped Flange-Jacks will open it easily. Write for descriptive folder!

THE GARLOCK PACKING COMPANY, PALMYRA, NEW YORK

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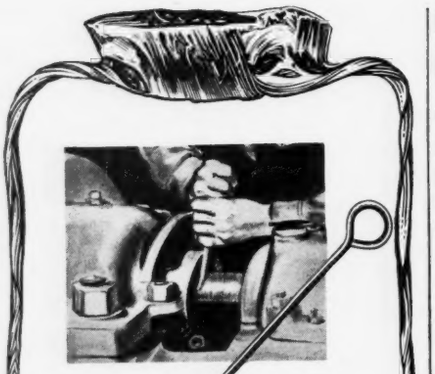
GARLOCK

MANUFACTURERS OF MECHANICAL PACKINGS AND GASKETS SINCE 1887



Give your Packing Hook a long vacation

Your pumps and valves won't need repacking for long intervals if you use PALMETTO. Each strand of PALMETTO is individually impregnated with special lubricant, while hot, under pressure. The resulting large reserve supply of lubricant *keeps* PALMETTO soft, pliable, and self-lubricating. So put PALMETTO in your stuffing boxes, then hang up the packing hook—you are sure not to need it for a long time to come.

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***PALMETTO**
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☐ Send free working sample of packing.....size, for ..... service.

Send free working sample of Palmetto Super-Sheat.

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Fan-Power Needs Important Consideration

WHERE THE POWER PLANT contains a number of steam generating units the problem of determining how the load shall be divided in order to handle a given steam demand in the most economical manner must be solved by the engineer. In setting up such a loading procedure it is not only necessary to consider the character of the demand curve but also the relative evaporative efficiency and maintenance costs of various combinations of steaming and standby units which might possibly be used to meet the specific requirements imposed by fluctuations in this curve.

Then too, the matter of power used by auxiliaries must be taken into account, especially that required by forced- and induced-draft fan systems. These particular auxiliaries are singled out because the ratio of the power demand to the load on the boiler is not constant but increases rapidly with increased steam output of individual boiler units.

Determination of boiler-fan-power requirements is very often complicated by the fact that the fans are operating under conditions quite different from those specified in the original performance curves supplied by the manufacturer. This condition is often encountered, especially in the case of induced-draft fans, because flue-gas temperatures frequently vary considerably from those expected when the equipment was specified. Where variations of either temperature or pressure prohibit the direct determination of power requirements from performance curves it becomes necessary to either use direct measurement or calculation.

Calculation of power fan requirements under conditions that are different from those covered by performance curves is quite simple when it is remembered that fan performance follows certain laws which, if applied correctly, can be used to closely determine capacity, horsepower, speed or pressure from these curves. These laws are:

1. When fan speed is changed: (a) capacity varies directly as the speed ratio; (b) pressure varies directly as the square of the speed ratio; (c) horsepower varies as the cube of the speed ration.

2. When system resistance is changed: (a) capacity and speed vary as the square root of the pressure; (b) horsepower varies as the cube root of the pressure squared.

(*Continued on page 188*)

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ADAMANT FIRE BRICK CEMENT
has a BONDING STRENGTH of 800 lbs. per sq. in. *at room temperature*
1270 lbs. per sq. in. at 2600° F

These are results of impartial tests on the average modulus of 5 test joints of Adamant whose high bonding strength makes joints stronger than the brick they bond. Adamant is made to a high quality standard, not down to a price.

ADAMANT has a P.C.E. of more than 3000° F.

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Babbitt *Adjustable* **SPROCKET RIM** *with Chain Guide*

MAKE YOUR OVERHEAD VALVES SAFE and EASY TO REACH—

CONTROL VALVES FROM THE FLOOR

With Babbitt Sprocket Rims on your overhead valves you can control valves instantly from the floor. Far quicker and safer than climbing ladders.

Babbitt Rims are easily attached in a few minutes, are inexpensive and assure safe, positive and instantaneous overhead valve operation. Available for valves of every make or style. Write for details.

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New Bedford Mass.

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THE

TYPE SG GOVERNOR

TYPE SG-B

for variable and constant speed application. This governor is of the hydraulic type, using engine lubrication oil as an energy medium. The lubricating oil pressure is increased by a gear pump; and controlled by a relief valve in the governor.

SPEED DROOP, or speed regulation, is used for stabilization, and may be externally set for optimum performance.

SPEED ADJUSTMENT, of the lever type, is provided for variable speed applications. A fixed speed adjustment, with a suitable amount of speed range, can be supplied for constant speed service.

The type SG governor can be provided with a useful work capacity of either six or twelve inch-pounds.

AND

TYPE UG8 GOVERNOR

DIAL CONTROL

for variable and constant speed service. The constant speed type has all of the necessary external controls and indications for generating service application. LOAD INDICATION; LOAD LIMIT; SPEED DROOP, adjustable from zero to five per cent. SPEED ADJUSTMENT may be made at the governor, or from the switchboard, by a synchronizing motor.

Lever type speed adjustment is provided for variable speed applications.

This governor is also of the hydraulic type, and contains its own supply of oil.

It has a total capacity of eight foot-pounds.

LEVER CONTROL

FOR FURTHER INFORMATION WRITE TO

WOODWARD GOVERNOR CO.

WORLD'S OLDEST AND LARGEST EXCLUSIVE MANUFACTURERS OF HYDRAULIC GOVERNORS FOR PRIME MOVERS

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CHOOSE MACWHYTE CABLES FOR THRIFTY PERFORMANCE

Philadelphia: In this great "city of brotherly love" lived wise Benjamin Franklin, whose lessons on thrift have always been well observed by Philadelphians.

Today, many Philadelphia thrift-minded building owners, managers, and engineers specify Macwhyte Special Traction Elevator Cables. Macwhyte cables provide what operators want: smooth operation at LOW-cost-per-car-mile.

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Kenosha, Wisconsin

3. When temperature varies (constant volume and speed): (a) horsepower and pressure vary directly as the air density or inversely as the absolute temperature.

4. When temperature varies (constant weight of air or gas): (a) capacity, speed and pressure vary inversely as the density or directly as the absolute temperature; (b) horsepower varies inversely as the square of the density or directly as the square of the absolute temperature.

5. When temperature varies (constant pressure): (a) speed, capacity and horsepower vary inversely as the square root of the density or directly as the square root of the absolute temperature.

6. When both temperature and pressure vary, (a) capacity and speed vary as the square root of the product of the pressure times the absolute temperature; (b) horsepower varies as the square root of the product of the pressure cubed times the absolute temperature.

In the foregoing laws, temperature is in degrees F, pressure is in inches of water, capacity in cu ft per min, density in lb per cu ft, and speed in rpm.

These calculations necessarily require a certain amount of time and effort and while new charts can be devised to meet local conditions, wattmeters in the fan power circuits are desirable, specially in the case of large steam-generating units. Supplementing the readings of the usual combustion-control instruments, the indications of these meters will afford the operator a continuous check on fan power consumption and also serve as a guide when changes become necessary in order to balance the boiler units at or near their most efficient operating points.

Roanoke, Va. S H COLEMAN

GREEN FUEL ECONOMIZER CO, INC, announces removal of their New York office to 165 Broadway, New York, N. Y., effective December 10. 1940.

STEEL & TUBES DIV, REPUBLIC STEEL CORP, announces appointment of C D Belt & Co, Denver, Colo., as sales agents for the Electrical Div, covering the states of Colorado, Wyoming and Montana.

At a special meeting of the board of directors of JOSEPH DIXON CRUCIBLE Co, Jersey City, N. J., the following officers were elected: J H Schermorhorn. president; E M Cabaniss and L F Bruce, vice-president; H W Armstrong, treasurer and director; and J P Templeton, secretary.

At the POWER SHOW-*Did you notice*

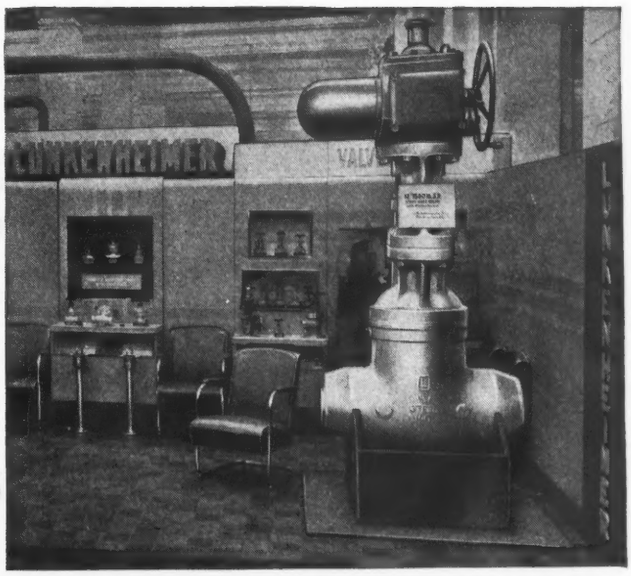
Five

FAMOUS VALVE MANUFACTURERS PROMINENTLY DISPLAYED the

PHILADELPHIA

Limitorque

VALVE CONTROL!



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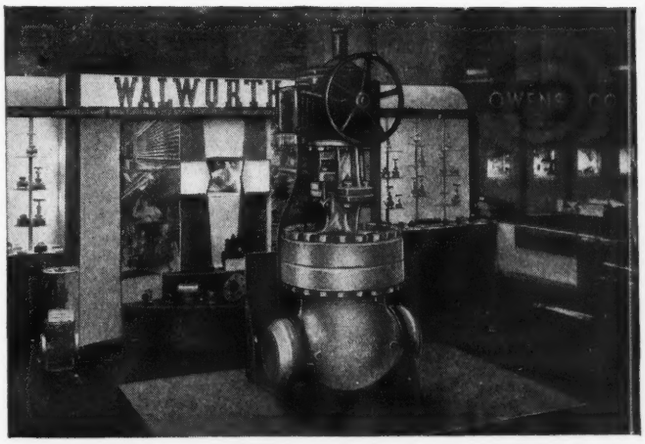
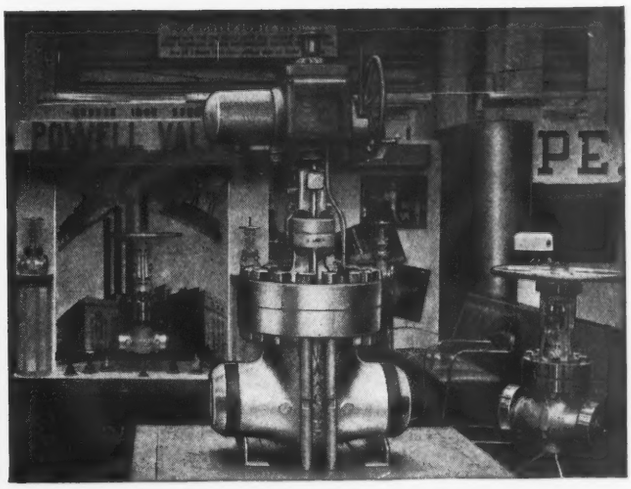
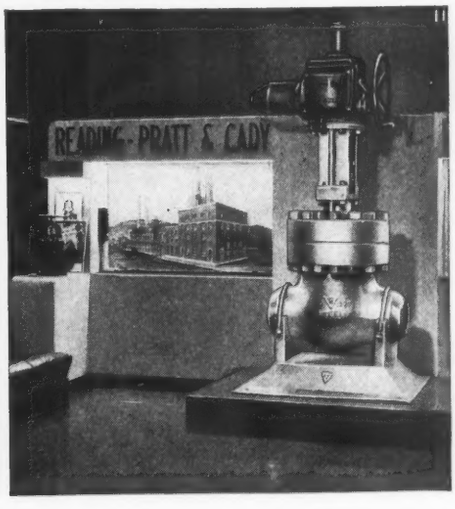






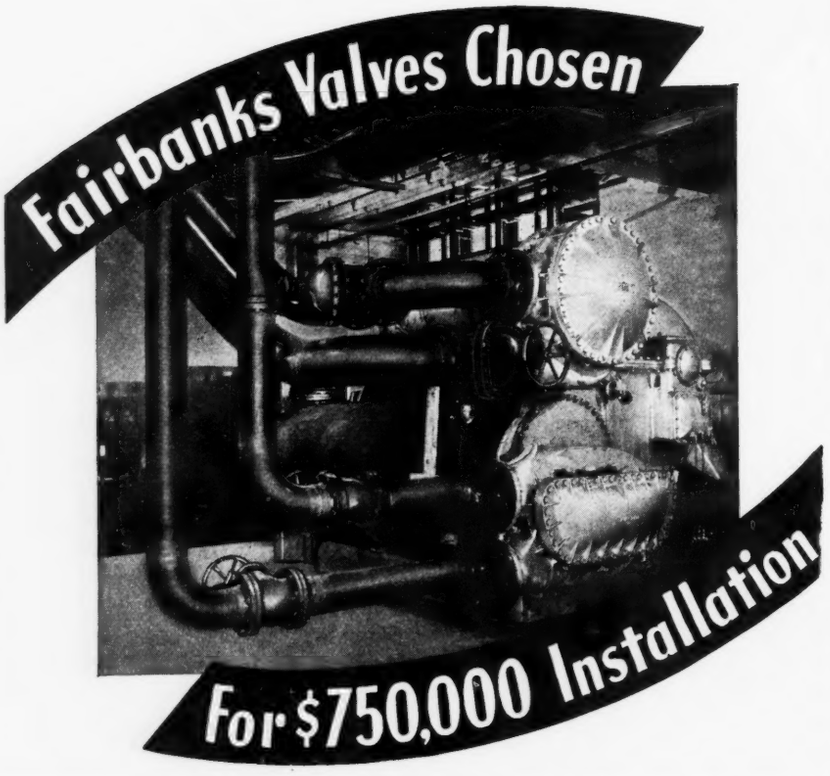


Illustration shows but a few of the Fairbanks Valves on the connections to the chilled water circulating pumps of the air-conditioning system of the Famous-Barr Corp.—the fifth largest department store in the nation. The Eichler Heating Co., St. Louis, had the distinction of installing here the largest air-conditioning system ever put in a retail business in this country.

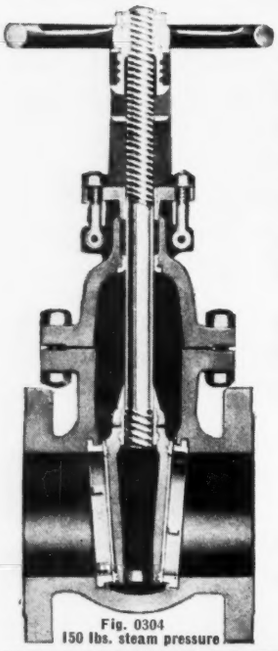


Fig. 0304
150 lbs. steam pressure

The reputation of Fairbanks Valves for dependable performance, long service and low upkeep cost is national. If *you* knew more about these valves you, too, would use them.

Why not write, while you think of it, for the name of our nearest distributor and catalog No. 21.

Fairbanks Valves are made in bronze and iron for a large range of pressures, in globe, gate, angle, check and cross patterns.

THE FAIRBANKS COMPANY

397 Lafayette St., New York, N. Y.

Valves, Dart Unions, Hand Trucks and Wheelbarrows

Boston, Mass., Pittsburgh, Pa.—Distributors in Principal Cities
Factories: Binghamton, N. Y., Rome, Ga.

Fairbanks F
Standard and Renewable **Valves**

J L Brown Promoted

J L Brown was elected a vice-president of United Engineers & Constructors at the December meeting of the Board of Directors. Mr Brown has had broad experience throughout the country in engineering and construction work. He has previously been associated with Lockwood Greene & Co, Charles T Main, and Stone & Webster Engineering Corp.

In 1919 Mr Brown became general superintendent of construction for Dwight P Robinson & Co, Inc, with headquarters in New York, and in 1928, upon the organization of United Engineers & Constructors, he came to Philadelphia as a construction manager.

Mr Brown is charged with responsibility for the construction work that United Engineers & Constructors is doing for public Service Electric & Gas Co of N. J.

Boston Edison Co to Build New Plant

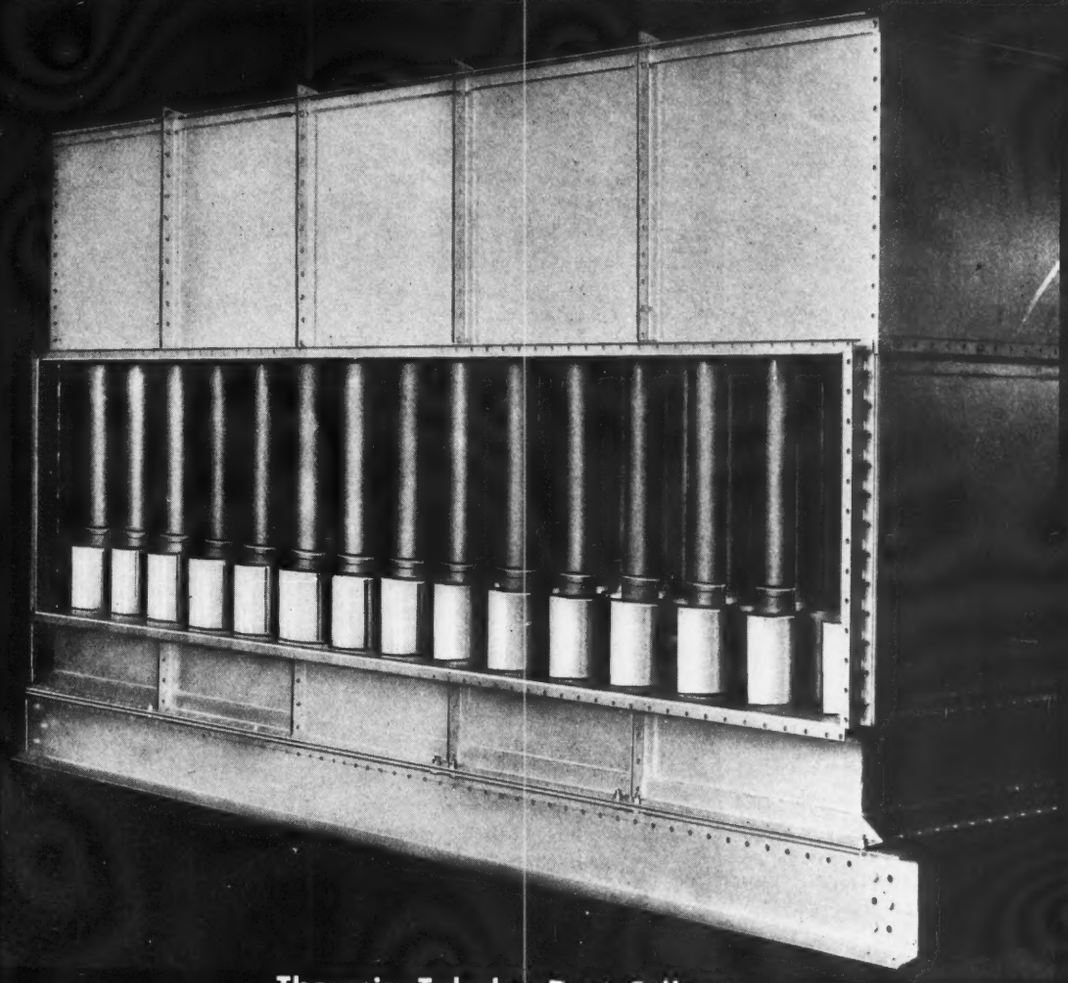
A new steam plant on the Mystic River at Everett, Mass., will be built by the Boston Edison Co, construction to start this spring, to meet load growth anticipated from defense industries. The initial equipment will include a 40,000-kw, high-pressure turbine-generator and 1200-lb, 900-F boiler. These were ordered for delivery in 1942.

Work has also been started on the installation of a 18,000-kw topping turbine for L Street Station, which will be delivered early in 1942. With the completion of these two projects, Boston Edison will have about 350,000 kw of modernized capacity and another 100,000 kw of reserve to meet emergencies or unusual peaks. There is still room at L Street and Edgar stations for additional capacity, but experience abroad points to the wisdom of greater decentralization of generating capacity under bombing hazards.

BLACKMER PUMP CO announces that contracts have been let for addition to plant and office building at Grand Rapids, Mich. New addition will double space of engineering department, increase office facilities, and add to testing and production departments.

STEEL & TUBES DIV, REPUBLIC STEEL CORP. announces appointment of C. D. Belt & Co, Denver, Colo., as sales agents for the Electrical Div, covering the states of Colorado, Wyoming and Montana.

Every Minute, 23,000,000 cu. ft. of Gas is Cleaned with Thermix Dust Collectors



Thermix Tubular Dust Collector

23,000,000 cu. ft. of gas being cleaned each minute with Thermix Dust Collectors represents experience and achievement. Fifteen years building centrifugal dust collectors for power plants means that our engineers have encountered and know the answers to the most difficult dust removal problems.

They also know which of the three types of Thermix Dust Collectors is best suited for your installation, whether the Thermix Controlled Multi-cyclone, with its patented control which assures high collection at low as well as high loads; the space-saving Thermix Tubular Dust Collector, which is remarkable for meeting most varying space requirements; or the Thermix Recirculator, which also acts as the Induced Draft Fan.

Write for catalog and full particulars.

Prat-Daniel Corporation
88 So. Water St. Port Chester, N.Y.

GET MORE from YOUR COAL DOLLARS

Buy Coal in Summer at Money-Saving Prices, Store It, and Reclaim in Winter

Here a large New York power plant stores over 400,000 tons of coal in the summer, uses two Carryalls for storing and reclaiming it.

You Can Do This Safely, Efficiently and at Low Cost with LeTourneau Carryalls

Now you can build up your coal reserves in summer when prices are low . . . when water routes are open and rail facilities good. And you can do it without fear of fire hazards, for LeTourneau Carryall Scrapers enable you to compact coal in thin, even, horizontal layers with fines and coarse thoroly mixed. Weight of the unit traveling over coal closely packs pile, eliminates flues and thus prevents spontaneous combustion. You can load directly from rail or dockside . . . haul and spread 25 to 200 tons hourly, depending on Carryall size and length of haul . . . reclaim the coal from storage pile later, thus eliminate extra handling equipment all around. Try it. Method has been thoroly proved by 3 years of use by some of the country's largest coal users. Initial cost and upkeep are comparatively low. Plan NOW to profit from summer coal prices . . . investigate this money-saving Carryall method. Ask your LeTourneau "Caterpillar" dealer for details . . . or write TODAY to Dept. 2P.

LETOURNEAU

PEORIA, ILLINOIS • STOCKTON, CALIFORNIA

Portable Transformer for Central N. Y. Power

The last word in supplying or restoring power to utility customers has been delivered by General Electric Co to the Central New York Power Corp at Syracuse, N. Y. It is a completely factory-built, 1000-kva mobile substation, mounted on a special chassis, which can be hauled at speeds up to 40 mph.

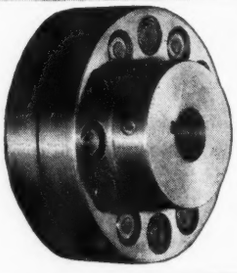
This substation makes the work of supplying or restoring power to customers in an emergency a comparatively simple matter. Installation is merely a matter of parking and grounding the unit, attaching incoming lines to one side and secondary system lines supplying the customer to the other. The substation consists of one 3-phase, 1000-kva transformer with primary and secondary switching equipment and lightning arrestors. It is designed to take power from high-voltage lines of 11,000, 13,200, 22,000, 33,000 or 44,000 volts, transform it and supply it to systems of 230, 460, 2300, 4000, or 4600 volts.

In addition to emergency service, the substation will also be used to bypass regular substations while repairs are being made or while maintenance work is being carried out, preventing interruption of service. Sudden demands for new power can likewise be taken care of while permanent substation facilities are being installed. Engineers of the power corporation estimated that the new mobile substation will be in use for at least three quarters of the year.

Although all were not required for the present unit, practically every feature of complete substation can be included in mobile units of some ratings, including disconnecting switches, lightning arrestors, load-ratio-control equipment, and metering and protective equipment. In addition to the new mobile unit, the Central New York Power Corp has located at Syracuse, Utica and Watertown, universal-type transformers, each of which have a capacity of 2500 kva, with secondary oil-circuit breakers. These can be used separately for customer's emergency requirements, or jointly in connection with the portable substation. Used in the latter manner a total capacity of 8500 kva can be obtained.

Over-all dimensions of the unit, including extensions, are 11 ft, 6 in. high, 21 ft long, and 8 ft wide. The height can be reduced to 9 ft 10 in., for low clearances. Total weight of the substation, including chassis, is almost 10 tons.

This AJAX CHECK CHART gives you the Answers about FLEXIBLE COUPLING DESIGN



	AJAX
DOES IT REQUIRE LUBRICATION? Ajax graphite-bronze bushings eliminate lubrication problems regardless of centrifugal force, angle of installation, or presence of dust or abrasive laden air.	NO
IS THERE A METAL FLEXING MEMBER SUBJECT TO FATIGUE? Constant compensation for misalignment sets up countless high speed flexing movements which result in fatigue and failure of metals. Ajax rubber bushings have inherent resiliency and recuperative powers to "take it."	NO
ARE THE RUBBER BUSHINGS SUBJECT TO FRICTION? In a flexible coupling, the rubber bushings should perform only ONE function . . . that of compensating for misalignment. Ajax rubber bushings are cold vulcanized to flanges . . . no friction . . . no scuffing . . . no wear.	NO
ARE THE RUBBER BUSHINGS SUBJECT TO SHEARING ACTION? In Ajax Flexible Couplings, hardened and ground steel studs in bronze bearings transmit all torque from driving to driven flange. Rubber bushings are not subject to shearing action between flanges.	NO
IS FREE END-FLOAT PROVIDED? Ajax design eliminates thrust between driving and driven machines. Electric generators or motors find their magnetic center.	YES
DOES IT PROVIDE DI-ELECTRIC INSULATION? Ajax rubber bushed design provides dielectric insulation between motors, generators, converters and driven machines at normal working voltages.	YES
DOES IT ELIMINATE BACKLASH? Ample bearing area . . . interlocking multiple drive studs . . . elimination of lubrication problems . . . precision machined to close tolerances . . . positive resilient drive,—all combine to eliminate backlash.	YES
IS IT QUIET IN OPERATION? Elimination of backlash . . . reduction of wear . . . rubber cushioning,—Ajax Flexible Couplings provide "rubber heels" for direct-connected machines. When it is quiet, it is efficient!	YES
WILL IT OPERATE IN ANY POSITION? Horizontal, vertical or installed at any angle,—it's all the same to Ajax. With no lubrication problems, Ajax Flexible Couplings perform for years, — not months!	YES

Expensive machines deserve the best protection against unavoidable misalignment, consequent wear and costly shut downs.

America's largest manufacturers have standardized on Ajax Flexible Couplings. Standard and shear pin types are built in complete range of sizes, from ½" bore up. Write for data book.

AJAX FLEXIBLE COUPLING CO.

132 English St. Westfield, N. Y.

Incorporated 1920

Also Manufacturers of Vibrating Screens, Conveyors, Packers